

STATISTICS
OF THE
IRON AND STEEL PRODUCTION
OF THE
UNITED STATES.

COMPILED BY

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LETTER OF TRANSMITTAL.

PHILADELPHIA, *June 1, 1881.*

HON. FRANCIS A. WALKER,
Superintendent of Census.

SIR: I have the honor to submit herewith my final report upon the iron and steel industries of the United States in the census year 1880. This report embraces complete statistics for that year of (1) blast furnaces and their products, (2) rolling mills and their products, (3) steel works and their products, and (4) forges and bloomaries and their products, accompanied by such comments and such statistical and historical summaries as have seemed to be proper and necessary.

The products of the blast furnaces embrace pig iron and a few furnace castings; the products of the rolling mills embrace all rolled iron, and such other finished iron articles, whether rolled or hammered, as a few of the mills make a specialty of producing; the products of the steel works embrace steel of every description in its crude state, and finished steel in various forms, whether rolled or hammered; the products of the forges embrace blooms made from pig and scrap iron; and the products of the bloomaries embrace blooms and hammered bar iron made directly from the ore.

The branches of the American iron and steel industries which are here enumerated may for convenience be termed the *productive* branches of those industries, in contradistinction to such *reproductive* branches as foundries, machine shops, anchor works, chain works, pipe and tube works, nut and bolt works, wire works, tack factories, etc., the collection of the statistics of which branches has been made directly by the Census Office. The productive branches above mentioned include all which produce iron and steel from raw materials, and, with the exception of iron foundries, all which produce iron and steel by what may be termed secondary operations. Iron foundries could not be embraced in the scope of this report because of their close association with machine shops and other reproductive branches, which are so extensive and varied and so infinitely ramified that no statistical machinery other than that of the Census Office itself could justly deal with them.

Some assurance may be desired by the public that the statistics which relate to the blast furnaces, rolling mills, steel works, and forges and bloomaries have been faithfully collected. An explanation of the manner in which these statistics have been obtained will probably satisfy this natural desire.

The American Iron and Steel Association has for years compiled at stated intervals a complete directory to all the iron and steel works above mentioned, embodying a detailed description of each establishment, the character of its product, the name and post-office address of its owners, its exact geographical location, etc. Through the co-operation of the Association with the plans of the Census Office a carefully revised edition of this directory was prepared and published a few weeks previous to the beginning of the census year. Special efforts were made after the publication of this edition to ascertain any changes or additions that might have taken place while it was passing through the press, and this supplementary work was continued until exact information concerning the location, ownership, and character of every establishment existing at the beginning of the census year is believed to have been obtained.

With a complete list in my possession of all the iron and steel works in the country whose statistics I had been requested to collect, the next step was to send, on the 1st day of June, 1880, to each company, or firm, or individual owning or controlling these works a schedule of interrogatories which had been prepared by the Census Office, accompanied by a circular letter over my signature requesting prompt answers, and explaining the nature

and importance of the inquiry which the Census Office had authorized to be made. Special stress was placed in this letter upon the provision in the law authorizing the Tenth Census which specified that any information contained in the schedules returned to the officers of the census should not be disclosed, except to superior officers. The result has been very gratifying. A large majority of the schedules were filled up and returned with reasonable promptness. Others were delayed from various causes, so that a second circular letter and protracted correspondence and personal visits became necessary. In extreme cases the aid of the telegraph was called into requisition. In only one case were coercive measures resorted to, and in only one other case was desired information withheld. That full answers to all interrogatories were not insisted upon in this latter case is due solely to lack of time, the final refusal to furnish information having been made too late to admit of further delay in closing the statistical tables for the country. With this single exception full replies to all interrogatories were made by the owners, lessees, or trustees of all the iron and steel works covered by the schedules, and the results were summarized and presented to the country in my preliminary report, dated April 1, 1881, exactly ten months after the inquiry was undertaken.

In the final report which is herewith submitted the statistics which have been obtained are arranged by states, by counties, by processes, and by products. The tables have been made as compact as was consistent with clearness, comprehensiveness, the gratification of the natural pride of locality, and the object of all true statistical research, which is the accumulation of useful information. To assist those who have not the time or the inclination to study the complete tables, the leading facts established by them have been presented a second time in condensed tables, and in connection with explanatory comments.

After presenting the results of the census of 1880 I have deemed it best, after careful deliberation, and with your approval, to supplement them with a brief historical sketch of the manufacture of iron and steel in all ages, and with a more elaborate sketch of the growth of the iron and steel industries of our own country from the earliest settlements to the present time. A knowledge of the world's iron history must be regarded as forming part of a useful education in an age like this, which is so proverbially identified with a liberal use of iron and steel; while a knowledge of our own iron history is essential to a full understanding of the causes of our national development. To know what the iron and steel industries have accomplished for our own country is a patriotic duty; to know something of their small beginnings and of the humble circumstances which surrounded the pioneers who planted them and their sons who struggled to sustain and extend them is a matter of patriotic pride. The greatness and the prominence of our country to-day in the production of iron and steel in large quantities and by scientific methods could in no other way be so satisfactorily exhibited as by affording the opportunity for a comparison of these magnificent results with the primitive methods and the meager results which characterized these industries in "good old colony times," or even a few years ago.

The historical chapters relating to the development of the iron and steel industries of our own country have been regarded as essential to the completeness of this report for another reason. They show that the manufacture of iron and steel has always been a favorite pursuit of the people of this country, and that primarily in every colony and afterwards in every state and territory their manufacture has been undertaken wherever the necessary raw materials have been found to exist. The manufacture of these products in our country dates from the earliest settlements upon the Atlantic coast, and it grew and expanded as rapidly as population increased and the repressive measures of the mother country would permit. After the Revolution it was extended into new states and territories as fast as a demand for iron and steel was created. With the exception of agriculture no American industry has been more widely diffused from the beginning of our history than the manufacture of iron and steel, and none has more generally enlisted the energy and progressive spirit of our people.

The historical survey embodied in this report may not be free from errors, but the utmost care has been taken to prevent errors and to guard against important omissions. The facts of history, especially of the world's industrial history, do not grow on trees, to be plucked by every passer-by, but are hid away in corners, where they can be found only by those who diligently search for them. The search for the leading facts in the world's iron history and in our own iron and steel history has been diligently made, and pains have been taken to verify the facts when found.

In the preparation of the historical chapters relating to the older countries of the world, I have relied for information mainly upon fragmentary statements in works of standard authority. All of these works that it was deemed necessary to mention specifically are referred to in connection with the information derived from them.

A small portion of the data for these chapters was obtained from current European technical publications, and by correspondence with gentlemen whose names are mentioned. In the preparation of the chapters relating to our own country less dependence has been placed upon statements already published, and more upon the results of original research, including a large correspondence with gentlemen in all parts of the country. All the sources of information of special importance are duly acknowledged in the text, except where details have been gathered from many sources. I desire, however, to express my great indebtedness to the *History of American Manufactures* prior to 1860 by Dr. J. Leander Bishop, one of the most industrious, accurate, and deserving of American historians; to *The Iron Manufacturer's Guide*, by Professor J. P. Lesley, published in 1859; and to the unvarying courtesy and sympathetic suggestions of the officers of the Historical Society of Pennsylvania, through whom I have had access to many rare books, pamphlets, and manuscripts relating to our colonial history.

In the collection and compilation of the statistics of 1880 I have had the intelligent assistance of Mr. George W. Cope and other gentlemen, which is thankfully acknowledged. To Mr. Cope my thanks are especially due.

I am, sir, very respectfully, your obedient servant,

JAMES M. SWANK,
Special Agent.

PART I.—STATISTICS.

SUMMARY OF IRON AND STEEL STATISTICS FOR 1880.

The complete statistical results of the census of the blast furnaces, rolling mills, steel works, forges, and bloomaries in the United States in the census year 1880 will be found in the accompanying tables. These results are here summarized, and as far as possible compared with results established by the census of 1870. The net ton of 2,000 pounds is invariably used in the tables and summary.

GRAND SUMMARY.

In the following table is presented a summary of the more important results established by the census of 1880, compared with similar results established by the census of 1870.

United States.	Number of establishments.	Amount of capital (real and personal) invested.	Value of all materials used.	Value of all products made.	Weight of all products (tons).	Total hands employed.	Total amount paid in wages.
Total in 1880	1,005	\$230,971,884	\$191,271,150	\$206,557,685	7,265,140	140,978	\$55,476,785
Total in 1870	808	\$121,772,074	\$135,526,132	\$207,208,696	8,655,215	77,555	\$40,514,981
Percentage of increase in 1880.....	24.38	89.68	41.13	48.12	98.76	81.78	36.93

ESTABLISHMENTS.

The whole number of establishments that were engaged in the manufacture of iron and steel in 1880, or were built or partly built to engage in their manufacture, was 1,005. In 1870 it was 808. The increase in the ten years was 24.38 per cent. By the term "establishment" is meant a single manufacturing enterprise, or an aggregation of enterprises of like character under one management. Thus one establishment may embrace two rolling mills, and another may embrace four blast furnaces. If, however, a firm or company operates two or more enterprises of different character, each of these enterprises is classed as a separate establishment. A comparison of the number of the various establishments in 1870 and 1880 is given below.

	1870.	1880.
Blast furnace establishments	386	490
Rolling mill establishments	310	324
Steel works	30	73
Forges and bloomaries	82	118
Total	808	1,005

The size and capacity of the establishments were much greater in 1880 than in 1870. As the capacity of blast furnaces only was given in 1870, no complete data are available for a comparison of the capacity of all the works in the two periods. The daily capacity of the blast furnaces in 1870 was 8,357 tons of pig iron, and in 1880 it was 19,248 tons, an increase of 130.32 per cent. The number of blast furnaces in 1870 was 574, and in 1880 it was 681, an increase of 18.64 per cent.

The following exhibit shows the number and capacity of the blast furnaces, rolling mills, steel works, forges, and bloomaries at the close of the census year 1880:

Blast furnace establishments	490
Completed blast furnaces	681
Rolling mill establishments	324
Puddling furnaces, each double furnace counting as two furnaces	4,319
Rotary puddling furnace (Sellers)	1
Danks puddling furnaces	19
Hammers in iron rolling mills	239
Heating furnaces	2,105
Trains of rolls in iron rolling mills	1,206
Nail machines	3,775

THE MANUFACTURE OF IRON AND STEEL.

Steel works.....	73
Bessemer steel converters.....	24
Open-hearth steel furnaces.....	37
Pot holes for crucible steel.....	2,691
Trains of rolls in steel works.....	136
Hammers in steel works.....	219
Forges and bloomaries.....	118
Forge and bloomary fires.....	495
Siemens rotator.....	1
Hammers in forges and bloomaries.....	141
Daily capacity of blast furnaces, in tons.....	19,248
Daily capacity of iron rolling mills, in tons.....	16,430
Daily capacity of Bessemer steel converters, in tons.....	4,467
Daily capacity of open-hearth steel furnaces, in tons.....	827
Daily capacity of Bessemer and open-hearth steel rolling mills, in tons.....	5,223
Daily capacity of crucible steel works, in tons.....	445
Daily capacity of forges and bloomaries, in tons.....	520

CAPITAL.

The whole amount of capital invested in 1880 in the iron and steel industries of the United States which are embraced in this report was \$230,971,884; in 1870 it was \$121,772,074: increase, \$109,199,810, or 89.68 per cent. Of the whole amount invested in 1880, Pennsylvania's share was 46 per cent.; that of Ohio was 11 per cent.; that of New York was 9 per cent.; and that of Missouri and New Jersey was each 4 per cent. No one of the other states shows an investment greater than three per cent.

TOTAL PRODUCTION.

The total production of the iron and steel works of the United States in 1880 was 7,265,140 tons; in 1870 it was 3,655,215 tons: increase, 3,609,925 tons, or 98.76 per cent. The phrase "total production" includes the products of all the various processes or operations, although in ascertaining most of these products there is a necessary duplication of the tonnage of raw or comparatively raw materials already stated. Thus rolled iron is mainly produced from pig iron. As the method of stating the production of 1880 is the same that was observed in 1870, a comparison of the results for both periods can not be open to objection.

PRODUCTION IN DETAIL.

The following table shows the production of each branch of our iron and steel industries in 1870 and 1880, with the percentage of increase or decrease in the latter year:

Iron and steel products.	Census year 1870.	Census year 1880.	Percentage of increase in 1880.	Percentage of decrease in 1880.	Iron and steel products.	Census year 1870.	Census year 1880.	Percentage of increase in 1880.	Percentage of decrease in 1880.
	<i>Tons.</i>	<i>Tons.</i>				<i>Tons.</i>	<i>Tons.</i>		
Pig iron and castings from furnace.....	2,052,821	3,781,021	84	.....	Crucible steel finished products.....	28,009	70,319	151	.....
All products of iron rolling mills.....	1,441,829	2,353,248	63	.....	Blister and other steel.....	2,285	4,958	117	.....
Bessemer steel finished products.....	19,403	889,896	4,486	.....	Products of forges and bloomaries..	110,808	72,557	.....	35.
Open-hearth steel finished products.....		93,143	.....	.....	Total.....	3,655,215	7,265,140	98.76	.....

Of the pig iron produced in the census year 1880, there were produced with charcoal and cold blast, 79,613 tons; with charcoal and hot-blast, 355,405 tons; with anthracite, 1,112,735 tons; with bituminous coal and coke, 1,515,107 tons; and with mixed anthracite and coke, 713,932 tons. The furnace castings amounted to only 4,229 tons. The total production was 3,781,021 tons, of which 12,875 tons were spiegeleisen.

In the following table is presented a comparative statement of iron rolling mill products in 1870 and 1880:

Iron rolling mill products.	1870.	1880.	Iron rolling mill products.	1870.	1880.
	<i>Tons.</i>	<i>Tons.</i>		<i>Tons.</i>	<i>Tons.</i>
Bar iron.....	488,834	663,211	Structural iron.....		96,810
Rod iron.....	26,087	145,026	Rolled iron axles.....		2,630
Nail-plate iron converted into cut nails.....	230,225	252,830	Hoop iron.....		96,843
Boiler-plate iron.....		89,560	Fish-plates and miscellaneous forms of rolled iron.....		48,845
All other plate iron.....	54,477	94,749	Railroad spikes, horseshoes, etc., made by iron rolling mills from rolled iron not included above.....		82,358
Sheet iron.....	74,753	94,992	Hammered axles.....		21,884
Iron rails.....	531,605	466,917	Forgings.....		3,703
Skelp iron.....	2,217	128,321	Total.....	1,441,829	2,353,248
Muck bar made for sale to other works.....	38,631	64,469			

The item of muck bar is an unavoidable duplication, as it reappears as finished iron to be counted a second time.

In the Bessemer and open-hearth steel works of the country the following finished products were produced in 1880:

Finished steel products.	Bessemer steel.	Open-hearth steel.
	Tons.	Tons.
Rails	741,475	9,105
Bars	76,710	43,290
Rods	49,004	1,184
Shapes	557	80
Sheets		1,700
Plates	1,475	11,034
Other forms	20,015	26,794
Total finished products	880,890	93,148

In the census year 1870 the production of Bessemer steel finished products was only 19,403 tons. No open-hearth steel products are reported for that year. The quantity of Bessemer steel ingots produced in the census year 1880 was 985,208 tons, and the quantity of open-hearth steel ingots was 84,302 tons. No statistics of ingots produced in 1870 are available for comparison. It will be observed that a larger quantity of finished open-hearth steel products was produced in 1880 than of ingots, which is probably due to the carrying over of ingots from the preceding year and to importations during the census year. The Bessemer steel ingots produced in 1880 are in excess of the finished products.

The increase in the production of crucible steel finished products in the decade between 1870 and 1880 was from 28,069 tons to 70,319 tons, or 151 per cent. The production of crucible steel ingots in 1880 was 76,201 tons. The production of blister steel and of steel made by other minor processes was only 2,285 tons in 1870 and 4,956 tons in 1880, and it is not likely to increase in the future.

There was a decrease of 35 per cent. in the production of the forges and bloomaries from 1870 to 1880, or from 110,808 tons to 72,557 tons. This decrease is due to the general substitution of improved processes for the forges and bloomaries of our earlier iron history, and it would have been much greater in the decade mentioned if the improved American bloomary, so largely used in northern New York, had not contributed its large product to swell the production of 1880.

RAW MATERIALS.

The following table presents the quantities of mineral products used by the iron and steel works in 1880:

Works.	Iron ore.	Limestone.	Anthracite coal.	Bituminous coal.	Coke.
	Tons.	Tons.	Tons.	Tons.	Tons.
Blast furnaces	7,256,684	3,109,149	2,615,182	1,051,753	2,128,255
Rolling mills	369,959		526,126	3,915,377	14,834
Bessemer and open-hearth steel works	7,327		140,458	465,655	104,980
Crucible steel works	2,128		46,892	224,657	22,791
Forges and bloomaries	79,610		840	1,613	6,695
Total	7,709,708	3,169,149	3,322,498	5,659,055	2,277,555

Of the iron ore and limestone given in the table, at least one-half was purchased from independent producers; of the anthracite coal, nearly all was so purchased; and of the bituminous coal and coke, fully two-thirds was so purchased.

The following table shows the quantities of all other leading raw materials used in 1880 in the manufacture of iron and steel:

Works.	Charcoal.	Mill cinder.	Pig iron.	Old iron rails.	Scrap iron.	Ore blooms.	Pig or scrap blooms.	Muck bar purchased.	Spiegel Eisen.	Old steel rails and scrap ends.	Bessemer steel ingots and blooms purchased.	Open-hearth ingots and blooms purchased.	Scrap steel.	Swedish billets and bars.	Other billets and bars.	Oil used as fuel.
	Bushels.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Bbls.
Blast furnaces	53,909,828	354,048														
Rolling mills	2,569,756		1,574,693	708,534	422,282	14,147	46,861	53,754								
Bessemer and open-hearth steel works	37,552		966,603		13,911	16,053	250		86,138	85,653	42,939	17,713	90,645			
Crucible steel works	60,594		17,226		1,952	18,211	2,400						19,726	10,410	16,406	
Forges and bloomaries	13,014,361		88,113		8,933											853
Total	69,592,091	354,048	2,596,635	708,534	447,078	43,411	49,511	53,754	86,138	85,653	42,939	17,713	110,371	10,410	16,496	853

THE MANUFACTURE OF IRON AND STEEL.

The large consumption of old iron rails and scrap iron in the rolling mills in 1880 was abnormal, and was the result mainly of the great scarcity of pig iron which followed the sudden revival of a demand for iron and steel products in the summer of 1879.

RELATIVE RANK IN PRODUCTION OF THE STATES.

The relative rank in production of all the states and territories which produced iron or iron and steel in 1870 and in 1880 is given in the following table.

States.	Production, 1880.	Rank.	States.	Production, 1870.	Rank.
	<i>Tons.</i>			<i>Tons.</i>	
Pennsylvania.....	3,616,668	1	Pennsylvania.....	1,836,808	1
Ohio.....	930,141	2	Ohio.....	449,768	2
New York.....	598,300	3	New York.....	448,257	3
Illinois.....	417,967	4	New Jersey.....	115,262	4
New Jersey.....	243,860	5	Maryland.....	95,424	5
Wisconsin.....	178,935	6	Missouri.....	94,890	6
West Virginia.....	147,487	7	Kentucky.....	86,732	7
Michigan.....	142,716	8	Michigan.....	86,679	8
Massachusetts.....	141,321	9	Massachusetts.....	86,146	9
Missouri.....	125,758	10	West Virginia.....	72,337	10
Kentucky.....	123,751	11	Indiana.....	64,148	11
Maryland.....	110,934	12	Wisconsin.....	42,234	12
Indiana.....	96,117	13	Virginia.....	37,836	13
Tennessee.....	77,106	14	Tennessee.....	34,305	14
Alabama.....	62,988	15	Illinois.....	25,761	15
Virginia.....	55,722	16	Connecticut.....	25,305	16
Connecticut.....	38,061	17	Maine.....	17,138	17
Georgia.....	35,152	18	Georgia.....	9,634	18
Delaware.....	33,918	19	Delaware.....	8,307	19
Kansas.....	19,055	20	Alabama.....	7,060	20
California.....	14,000	21	Rhode Island.....	4,415	21
Maine.....	10,866	22	California.....	3,000	22
Wyoming Territory.....	9,790	23	North Carolina.....	1,801	23
Rhode Island.....	8,134	24	Vermont.....	1,525	24
New Hampshire.....	7,978	25	South Carolina.....	443	25
Vermont.....	6,620	26	Kansas.....		
Colorado.....	4,500	27	Wyoming Territory.....		
Oregon.....	3,200	28	New Hampshire.....		
Nebraska.....	2,000	29	Colorado.....		
Texas.....	1,400	30	Oregon.....		
North Carolina.....	439	31	Nebraska.....		
District of Columbia.....	264	32	Texas.....		
South Carolina.....			District of Columbia.....		
Total.....	7,265,140		Total.....	3,655,215	

Twelve states made over 100,000 tons each in 1880. Pennsylvania, which for more than a hundred years has been the leading iron-producing state in the Union, made in 1870 a fraction over 50 per cent. of the total product, and in 1880 it made a fraction under 50 per cent. At both periods its prominence in the production of iron and steel was virtually the same. From 1870 to 1880 it increased its production 97 per cent., or from 1,836,808 tons to 3,616,668 tons. Ohio was the second state in prominence in 1870, and it held the same rank in 1880. In the former year it produced 449,768 tons, and in 1880 it produced 930,141 tons, an increase of 107 per cent. The third state in prominence in 1870 was New York, and it maintained this rank in 1880, but its growth fell far below that of its two sister states above mentioned. In 1870 it produced 448,257 tons, and in 1880 it produced 598,300 tons, an increase of 33 per cent. New Jersey was fourth in rank in 1870, producing 115,262 tons, but it was fifth in 1880, although in that year it produced 243,860 tons, an increase of 112 per cent. The fourth place in 1880 was taken by Illinois, which produced in 1870 only 25,761 tons, while in 1880 it produced 417,967 tons, an increase of 1,522 per cent.—the most marvelous in the history of the country. Maryland ranked fifth in 1870, producing 95,424 tons in that year, while in 1880 it produced only 110,934 tons, an increase of 16 per cent., causing it to drop to the twelfth place. The sixth state in rank in 1870 was Missouri, with a production of 94,890 tons, which was increased to 125,758 tons in 1880, or 33 per cent., giving it the tenth place in that year. The seventh state in rank in 1870 was Kentucky, but it fell to the eleventh place in 1880, increasing its production from 86,732 tons to 123,751 tons, or 43 per cent. Michigan ranked eighth in 1870, and in 1880 its rank was the same, its production increasing in the ten years from 86,679 tons to 142,716 tons, or 65 per cent. Massachusetts was ninth in rank in 1870, and it held the same rank in 1880, increasing its production from 86,146 tons to 141,321 tons, or 64 per cent. Of the New England states,

Massachusetts shows the greatest actual growth in the ten years. West Virginia was tenth in the list in 1870 and seventh in 1880, increasing its production from 72,337 tons to 147,487 tons, or 104 per cent. Wisconsin was twelfth in rank in 1870, but passed to the sixth place in 1880, increasing its production from 42,234 tons to 178,935 tons, or 324 per cent. This state ranks next to Illinois among the western states.

Of the states which made less than 100,000 tons in 1880, several gave promise in that year that they would soon reach an annual production of at least this quantity. Indiana narrowly escaped accomplishing this result, increasing its production from 64,148 tons in 1870 to 96,117 tons in 1880, or 50 per cent. In the ten years from 1870 to 1880 Alabama increased from 7,060 tons to 62,986 tons, or 792 per cent. Georgia increased from 9,634 tons to 35,152 tons, or 265 per cent. Tennessee increased from 34,305 tons to 77,100 tons, or 125 per cent. Delaware increased from 8,307 tons to 33,918 tons, or 308 per cent. Virginia increased from 37,836 tons to 55,722 tons, or 47 per cent.

All the states which made iron or steel in 1870 increased their production in 1880, except Maine, North Carolina, and South Carolina. The greatest percentage of increase in the decade was in the western states, beginning with Ohio, and in the southern states, beginning with Delaware, but the greatest actual increase was in Pennsylvania.

GEOGRAPHICAL DISTRIBUTION OF ALL PRODUCTS.

The whole territory of the United States may be regarded as comprising four grand divisions—the eastern states, the southern states, the western states and territories, and the Pacific states and territories. Assuming that the eastern states comprise all of the states lying north of Delaware and east of Ohio, that the southern states comprise all of the late slaveholding states except Missouri, and that the other divisions require no explanation, we present the following comparative statement of the development of our iron and steel industries in each of the grand divisions in the census year 1880.

Grand divisions.	Number of establishments.	Capital invested.	Hands employed.	Wages paid.	Tons produced.	Value of all products.
Eastern states	556	\$149,507,461	82,842	\$34,361,660	4,671,808	\$192,600,010
Southern states	218	29,145,830	20,595	6,261,344	649,153	25,353,251
Western states and territories	224	50,755,090	36,603	14,542,587	1,912,689	76,933,686
Pacific states and territories	7	1,562,003	878	811,194	31,490	1,574,738
Total United States	1,005	\$230,971,884	140,978	\$55,476,785	7,265,140	\$296,557,685

In the decade between 1870 and 1880 the iron industry was extended into many new states and territories. Twenty-five states were engaged in the manufacture of iron or iron and steel in 1870. Thirty states, the District of Columbia, and Wyoming Territory made iron in 1880, and about the half of these also made steel. South Carolina made iron in 1870, but does not appear in the statistics for 1880. Its total production in 1870 did not, however, aggregate 500 tons. The iron industry in this state has been practically abandoned. Between 1870 and 1880 three states for the first time engaged in the manufacture of iron, namely, Colorado, Kansas, and Nebraska; also two territories, namely, Utah and Wyoming. Utah did not, however, make any iron in 1880. It made a small quantity in each of the years 1874, 1875, and 1876, and it will make a larger quantity in the near future. (Since the close of the census year 1880 Washington Territory has commenced to manufacture pig iron, as have also California and Minnesota. California had previously, since 1868, rolled iron at San Francisco.) Minnesota appears in 1880 among iron-manufacturing states, but its statistics relate only to the preparations that had been made to embark in the business. New Hampshire made iron many years ago, but it does not appear in the statistics for 1870; it reappears in the tables for 1880. Oregon and Texas each built a blast furnace in the decade preceding the census year 1870, but they did not make any iron in that year; they appear, however, in the statistics of production for 1880. The District of Columbia once had a blast furnace in operation, but in 1870 it had no iron industry whatever; in 1880 the United States government owned and operated a small rolling mill at the Washington navy yard.

The percentage of total production in 1880 was distributed as follows: Pennsylvania, 50 per cent.; Ohio, 13; New York, 8; Illinois, 6; New Jersey, 3; Wisconsin and West Virginia, each over 2 per cent.; Michigan and Massachusetts, each nearly 2 per cent.; Missouri, Kentucky, and Maryland, each over 1½ per cent.; Indiana, over 1 per cent.; Tennessee, about 1 per cent.; and all other states and territories, an aggregate of about 4 per cent.

CENTERS OF PRODUCTION.

In the following table is presented a view of the principal centers of production of the iron and steel industries of the United States in the census year 1880. These centers are divided into two classes—the first comprising fifteen counties which produced over 100,000 tons of pig iron, blooms, and finished products, and the second

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comprising seventeen counties which produced over 60,000 and less than 100,000 tons. Six states are represented in the first class, and eight states in the second class.

COUNTIES OF THE FIRST CLASS, PRODUCING OVER 100,000 TONS.		COUNTIES OF THE SECOND CLASS, PRODUCING BETWEEN 60,000 AND 100,000 TONS.	
Counties.	Tons.	Counties.	Tons.
1. Allegheny county, Pa.....	848, 146	1. Lawrence county, Pa.....	88, 443
2. Lehigh county, Pa.....	324, 875	2. Lancaster county, Pa.....	87, 019
3. Northampton county, Pa.....	322, 882	3. Ohio county, W. Va.....	84, 767
4. Cambria county, Pa.....	260, 140	4. Will county, Ill.....	84, 094
5. Cook county, Ill.....	248, 479	5. Montour county, Pa.....	79, 789
6. Dauphin county, Pa.....	223, 676	6. Chester county, Pa.....	78, 363
7. Mahoning county, Ohio.....	219, 937	7. Warren county, N. J.....	76, 622
8. Berks county, Pa.....	213, 580	8. Trumbull county, Ohio.....	73, 380
9. Cuyahoga county, Ohio.....	210, 354	9. Lebanon county, Pa.....	73, 149
10. Mercer county, Pa.....	182, 881	10. Lawrence county, Ohio.....	70, 794
11. Rensselaer county, N. Y.....	177, 967	11. Schuylkill county, Pa.....	70, 609
12. Montgomery county, Pa.....	168, 628	12. Baltimore county, Md.....	69, 944
13. Lackawanna county, Pa.....	151, 273	13. Blair county, Pa.....	68, 039
14. Milwaukee county, Wis.....	128, 191	14. Essex county, N. Y.....	66, 725
15. St. Louis county, Mo.....	102, 044	15. Philadelphia county, Pa.....	65, 983
		16. Wayne county, Mich.....	63, 548
		17. Dutchess county, N. Y.....	61, 637
Total (15 counties).....	8, 783, 678	Total (17 counties).....	1, 262, 894

THE CENTER OF TOTAL PRODUCTION.

The geographical center of total production of the iron and steel industries of the United States is the point at which equilibrium would be established were the country taken as a plane surface, itself without weight but capable of sustaining weight, and loaded with its production of iron and steel, each ton exerting pressure on the pivotal point directly proportioned to its distance therefrom.

The center of production of iron and steel in the United States in the census year 1880 is found to be at 40° 43' north latitude and 79° 20' longitude west from Greenwich. This point is in Pennsylvania, on the boundary line between Armstrong and Indiana counties, and about 12 miles northeast of Apollo and 12 miles west of Indiana—Laufman & Co.'s rolling mill at Apollo being the nearest iron works. At the center of production thus ascertained iron has never been manufactured in any form.

VALUES.

There is a striking disproportion between the values of raw materials and of all products in 1870 and 1880 upon the one hand and the weight of all products in these periods upon the other. The percentage of increase in the values of raw materials and of all products in 1880 over 1870 was 41.13 and 43.12 respectively, while the weight of all products increased 98.76 per cent. The explanation is simple, and is twofold. First, the census year 1870 was a year of high prices, caused partly by an average gold premium throughout the year of about 15 per cent., and partly by other well-known causes. Second, the census year 1880 was not only a year of lower average prices than 1870, but it may be said to have closed a decade of wonderful mechanical and scientific development in the American iron and steel industries, through which the production of large masses of both crude and finished products was rendered possible.

GEOGRAPHICAL DISTRIBUTION OF SPECIAL PRODUCTS.

The various branches of our iron and steel industries have not been equally domesticated in each of the four grand geographical divisions that have been mentioned, and much less can it be said that they are equally at home in any one of the iron-making states or territories. While this statement may embody only a self-evident truth, the full significance of the fact stated is deserving of some consideration. A glance at the statistics for 1880 shows that New England now makes but little pig iron, and that the South makes considerable pig iron and scarcely any rolled iron; that the West has embarked largely in the manufacture of steel by the Bessemer process, while New England can not boast a single Bessemer establishment, but has preferred the open-hearth process; that New York makes most of the blooms that are made from ore, and Pennsylvania most of the blooms that are made from pig and scrap iron; that Michigan is the leading producer of charcoal pig iron, and now makes no other kind; that West Virginia has developed a remarkably active interest in the manufacture of cut nails; that only five states make Bessemer steel, and two states, Pennsylvania and New Jersey, make nearly all of our crucible steel; and that Pennsylvania has made a greater effort than any other state to manufacture all kinds of iron and steel. A glance, however, at leading geographical characteristics is not sufficient to illustrate the wide diversity of the influences which have affected the local development of our iron and steel industries, and the following details are therefore added.

PIG IRON.

Of 3,781,021 tons of pig iron and direct castings produced in 1880 in 22 states, Pennsylvania made 1,930,311 tons, or 51 per cent.; Ohio, 548,712 tons, or 15 per cent.; New York, 313,368 tons, or 8 per cent.; New Jersey, 157,414 tons, or 4 per cent.; Michigan, 119,586 tons, and Wisconsin, 118,282 tons—each over 3 per cent.; Illinois, 95,468 tons, and Missouri, 95,050 tons—each nearly 3 per cent.; West Virginia, 80,050 tons, or over 2 per cent.; Alabama, 62,336 tons, Maryland, 59,664 tons, and Kentucky, 58,108 tons—each over $1\frac{1}{2}$ per cent.; Tennessee, 47,873 tons, or over 1 per cent.; and all other states and territories, each less than 1 per cent.

Anthracite pig iron was produced in Pennsylvania, New York, New Jersey, Massachusetts, and Maryland—the last two states producing but little. Pig iron produced with a mixture of anthracite and coke was made in Pennsylvania, New York, Wisconsin, Illinois, New Jersey, and Maryland. Pig iron produced with bituminous coal and coke was made in Pennsylvania, Ohio, West Virginia, Missouri, Tennessee, Kentucky, Indiana, Illinois, Alabama, Georgia, Virginia, and Maryland. Charcoal pig iron was made in all of the states that made pig iron in 1880, with the exception of Illinois and New Jersey, which used mineral fuel exclusively.

ROLLED IRON.

Of 2,353,248 tons of rolled iron of all kinds produced in 29 states and territories in 1880, Pennsylvania made 1,071,098 tons, or 46 per cent.; Ohio, 272,094 tons, or 12 per cent.; New York, 163,538 tons, or 7 per cent.; Illinois, 117,051 tons, and Massachusetts, 109,252 tons—each 5 per cent.; Indiana, 77,880 tons, or over 3 per cent.; West Virginia, 67,437 tons, New Jersey, 66,030 tons, Kentucky, 65,293 tons, and Wisconsin, 60,653 tons—each a little less than 3 per cent.; Maryland, 47,609 tons, or 2 per cent.; Virginia, 35,176 tons, and Delaware, 33,918 tons—each about $1\frac{1}{2}$ per cent.; Tennessee, 25,381 tons, or 1 per cent.; and all other states and territories, each less than 1 per cent.

Of 466,917 tons of iron rails produced in 1880, Pennsylvania made 34 per cent.; Illinois, 16 per cent.; Ohio, 9 per cent.; Indiana, 8 per cent.; New York, 7 per cent.; Wisconsin, 6 per cent.; Kentucky, 4 per cent.; Kansas and Tennessee, each nearly 3 per cent.; Wyoming Territory, Maryland, and Georgia, each about 2 per cent.; California and Massachusetts, each 1 per cent.; and Colorado, West Virginia, and Vermont, each less than 1 per cent.

Of the cut nails produced in 1880, Pennsylvania made 30 per cent.; West Virginia, 21 per cent.; Ohio, 14 per cent.; Massachusetts, 10 per cent.; New Jersey and Indiana, each 6 per cent.; Illinois and Kentucky, each 4 per cent.; and Tennessee and Virginia, each 2 per cent. New York, Nebraska, and Maine each produced less than 1 per cent., but Nebraska made more nails than New York. The whole number of kegs of cut nails made in the United States in 1880 was 5,056,600, each keg weighing 100 pounds.

STEEL INGOTS.

The following table shows the states which produced Bessemer, open-hearth, and crucible steel ingots in 1880.

States.	Bessemer steel ingots.	Open-hearth steel ingots.	Crucible steel ingots.
	Tons.	Tons.	Tons.
Connecticut.....			2, 116
Illinois.....	253, 514	925	130
Kentucky.....		275	75
Massachusetts.....		9, 475	140
Missouri.....	8, 409		
New Hampshire.....		4, 521	
New Jersey.....		450	10, 492
New York.....	84, 160		2, 585
Ohio.....	82, 811	24, 712	360
Pennsylvania.....	556, 814	36, 944	60, 303
Tennessee.....		4, 000	
Vermont.....		3, 000	
Total.....	985, 208	84, 302	76, 201

BESSEMER STEEL.

Of the production of 985,208 tons of Bessemer steel ingots in 1880, Pennsylvania made 56 per cent.; Illinois, 26 per cent.; New York, 9 per cent.; Ohio, 8 per cent.; and Missouri, less than 1 per cent. Of the production of Bessemer steel rails, Pennsylvania made 55 per cent.; Illinois, 27 per cent.; Ohio, 9 per cent.; New York, 8 per cent.; and Missouri and Vermont, each less than 1 per cent. The last-named state had, however, no works for the production of Bessemer steel ingots. At the close of the census year there were 24 Bessemer converters in the United States, of which 6 were in Illinois, 2 were in Missouri, 2 were in New York, 2 were in Ohio, and 12 were in Pennsylvania.

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OPEN-HEARTH STEEL.

Of the production of 84,302 tons of open-hearth steel ingots in 1880, Pennsylvania made 44 per cent.; Ohio, 29 per cent.; Massachusetts, 11 per cent.; New Hampshire and Tennessee, each 5 per cent.; Vermont, 4 per cent.; and Illinois, New Jersey, and Kentucky, each less than 1 per cent. Of the open-hearth steel ingots produced in 1880, only a small quantity was converted into rails, the weight of these being 9,105 tons. At the close of the census year 1880 there were 37 open-hearth furnaces in the United States, of which 2 were in Illinois, 1 was in Kentucky, 4 were in Massachusetts, 1 was in New Hampshire, 1 was in New Jersey, 10 were in Ohio, 14 were in Pennsylvania, 1 was in Rhode Island, 2 were in Tennessee, and 1 was in Vermont.

CRUCIBLE STEEL.

Of the production of 76,201 tons of crucible steel ingots in 1880, Pennsylvania made 60,303 tons, or 79 per cent.; New Jersey, 10,492 tons, or 14 per cent.; New York, 2,585 tons, or over 3 per cent.; Connecticut, 2,116 tons, or under 3 per cent.; and Ohio, Massachusetts, Illinois, and Kentucky, an aggregate of less than 1 per cent. Pennsylvania, New Jersey, and Connecticut also unitedly produced 4,956 tons of blister steel and miscellaneous steel products, of which Pennsylvania produced 78 per cent.; New Jersey, 20 per cent.; and Connecticut, 2 per cent.

BLOOMS AND BAR IRON FROM ORE.

The total production of these products in 1880, nearly all of which, however, was in the form of blooms, was 37,633 tons, of which New York produced 84 per cent.; Missouri, 11 per cent.; Tennessee, 2 per cent.; New Jersey and North Carolina, each over 1 per cent.; and Pennsylvania, Georgia, and Virginia, an aggregate of less than 1 per cent. Pennsylvania's product was made in a Siemens rotator; that of North Carolina, Georgia, Virginia, and Tennessee by the old-fashioned Catalan process; that of Missouri by the Peckham process; while the more considerable product of New York was almost wholly made in American bloomaries—an improvement on the Catalan forge. The very small quantity of bar iron made from ore in 1880 was all made in Virginia, North Carolina, Georgia, and Tennessee bloomaries. It aggregated but little over 1,000 tons.

BLOOMS FROM PIG AND SCRAP IRON.

Of 34,924 tons of blooms of this character made in 1880, Pennsylvania produced 70 per cent.; Maryland and New Jersey, each 10 per cent.; Virginia, 7 per cent.; Georgia, over 1 per cent.; Tennessee, about 1 per cent.; and New York and Massachusetts together, less than 1 per cent.

ALL KINDS OF RAILS.

The production of rails of all kinds in 1880 is given in the following table in connection with the states which produced them. The tonnage of rails produced in 1880 was greater than that of any other rolled product, and was about one-third that of pig iron.

States.	Iron rails.	Bessemer steel rails.	Open-hearth steel rails.	Total production of all kinds of rails.
	Tons.	Tons.	Tons.	Tons.
California.....	6,000			6,000
Colorado.....	4,500			4,500
Georgia.....	8,673			8,673
Illinois.....	72,802	201,186		273,988
Indiana.....	38,600			38,600
Kansas.....	13,500			13,500
Kentucky.....	18,000			18,000
Maryland.....	9,280			9,280
Massachusetts.....	5,600			5,600
Missouri.....		5,100		5,100
New York.....	34,305	57,870		92,175
Ohio.....	41,838	68,480		108,318
Pennsylvania.....	157,218	400,339	3,360	560,917
Tennessee.....	12,800		2,745	15,545
Vermont.....	1,500	1,500	3,000	6,000
West Virginia.....	3,333			3,333
Wisconsin.....	29,552			29,552
Wyoming Territory.....	9,421			9,421
Total.....	466,917	741,475	9,105	1,217,497

Pennsylvania made 47 per cent. of the total production of rails; Illinois, 23 per cent.; Ohio, 9 per cent.; New York, 8 per cent.; Indiana, 3 per cent.; Wisconsin, 2 per cent.; Kentucky, Tennessee, and Kansas, each 1 per cent.; and all other states and Wyoming Territory, each less than 1 per cent.

LABOR.

In the following table is presented a summary of the hands employed, hours of labor required, and wages paid in the iron and steel industries of the United States in 1880, compared as far as possible with like statistics for 1870.

United States.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Total hands employed.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages.
Grand total in 1880.....	133,203	7,709	45	21	140,978	65	\$2 59	\$1 24	\$55,476,785
Grand total in 1870.....	75,037	2,430	82		77,555				\$40,514,981
Percentage of increase in 1880.....	77.52	216.46			81.78				30.93
Percentage of decrease in 1880.....			45.12						

HANDS EMPLOYED AND WAGES PAID.

The total number of hands employed in 1880 was 140,978. Of the whole number, 133,203 were men above 16 years old, and 45 were women above 15 years old; 7,709 were boys below 16 years old, and 21 were girls below 15 years old. The remarkably small number of 66 women and girls employed in the manufacture of iron and steel in 1880 will not escape notice, and is exceedingly creditable to our American civilization. The comparatively small number of boys employed is also worthy of notice.

The 140,978 persons who were employed in 1880 were paid \$55,476,785 as wages, or an average of \$393 51 for the year for each person. The average daily wages of skilled labor were \$2 59; of unskilled labor, \$1 24. The highest average daily wages of skilled labor were paid in Rhode Island, Colorado, and Wyoming Territory—\$4; the lowest in North Carolina—\$1 25. The highest average daily wages of unskilled labor were paid in Wyoming Territory—\$2; the next highest in Colorado and California—\$1 75; the lowest in North Carolina—54 cents. It may be remarked of North Carolina that its iron industry in 1880 was wholly confined to the use of the primitive ore bloomery, and that the labor employed was largely that of colored men. The average wages paid in the four grand divisions were as follows: Eastern states—skilled, \$2 70; unskilled, \$1 21; southern states—skilled, \$2 09; unskilled, \$1 03; western states—skilled, \$2 70; unskilled, \$1 31; Pacific states and territories—skilled, \$3 50; unskilled, \$1 75.

It is necessary to explain that the figures of "hands employed" and "wages paid" refer to the labor directly employed at the various iron and steel works of the country, and in the mining and other operations conducted in direct connection with these works. They do not include the labor employed in independent and often remote mining operations which supply our iron and steel industries with ore and coal and other raw materials. (The statistics of these operations are being compiled by other hands.) Nor do they include any considerable part of the labor employed in the transportation of raw materials from the sources of production to the places of consumption. If the "hands employed" and "wages paid" in these various contributory channels were added to the figures given in our tables, the total number of persons directly supported by our iron and steel industries in 1880, and the total amount of wages paid to them, would be largely increased and probably doubled.

HOURS OF LABOR.

The average number of hours of labor required per week in the iron and steel works of the United States in 1880 was 65. This gives a little less than 11 hours for each working day of the week. The average is high, in consequence of the general although not universal practice of operating blast furnaces seven days in the week, and in consequence also of the usual practice at blast furnaces, rolling mills, and steel works of working twelve-hour turns or shifts, which practice may require the presence of the workmen for that length of time, although they may not be, and generally are not, so long actually employed. The state which presents the highest average is Vermont—75 hours, while the lowest average in any of the states is found in Delaware and Kansas—56 hours. A still lower average is found in the District of Columbia—54 hours.

A YEAR OF PROSPERITY.

The census year 1880, which it may here be stated extended from the 1st of June, 1879, to the 31st of May, 1880, was a year of exceptional prosperity for the iron and steel industries of this country. The coincidence is notable that it exactly covered the period which has been designated as "the boom," during which all iron and steel products were in such great demand by American consumers that the iron and steel works of the country were unable to meet it. The home supply was supplemented by large importations, and even these could not be made with sufficient rapidity to meet the urgent wants of consumers. Prices were high throughout the whole year, but fluctuated violently. Labor was in demand, wages were promptly paid, and disputes between workmen and their employers were rare and unimportant. The census year 1880 will long be memorable as a year of general prosperity for our iron and steel industries, and as one which witnessed the beginning and the end of a most exciting epoch in their history.

THE MANUFACTURE OF IRON AND STEEL.

TABLE I.—THE BLAST FURNACES

STATES AND TERRITORIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.				WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Number of completed stacks.	Total daily capacity, in tons of melted metal.
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.			
Total	400	\$105,151,176	41,875	40,683	1,183	0	72	\$1 90	\$1 17	\$12,680,703	8	681	* 19,248
1 Alabama	12	3,106,196	1,566	1,531	35	76	76	2 34	98	553,713	10	15	330
2 Connecticut	8	1,297,000	130	130	12	78	78	1 48	1 17	65,074	8	8	91
3 Georgia	9	819,100	754	742	1	65	65	1 76	93	77,415	7	10	144
4 Illinois	7	1,515,000	408	407	1	72	72	2 17	1 33	185,054	8	10	603
5 Indiana	3	455,000	308	293	15	77	77	1 88	1 07	54,840	8	4	73
6 Kentucky	19	2,681,035	1,890	1,810	80	75	75	1 50	1 25	44,950	10	22	392
7 Maine	3	150,000	300	300	42	69	69	1 88	1 25	339,978	7	1	18
8 Maryland	1	2,707,125	1,443	1,401	42	71	71	1 86	1 50	170,000	7	6	81
9 Massachusetts	16	682,000	390	390	28	80	80	2 00	1 29	561,870	7	27	844
10 Michigan	4	3,504,386	2,104	180	180	74	74	2 32	1 20	25,275	9	9	40
11 Minnesota	20	150,000	180	180	25	71	71	1 75	1 14	227,111	10	1	749
12 Missouri	1	5,053,372	1,185	1,100	24	76	76	1 77	1 14	227,111	9	17	691
13 New Jersey	12	2,694,500	1,174	1,150	37	74	74	2 32	1 20	865,639	10	20	1,654
14 New York	13	10,128,221	2,518	2,481	37	74	74	2 32	1 20	902,029	9	57	20
15 North Carolina	39	470,000	8,944	8,548	396	74	74	1 84	1 25	2,725,157	9	108	3,201
16 Ohio	5	14,606,019	250	247	3	72	72	3 00	1 50	40,822	9	1	12
17 Oregon	82	100,000	13,460	13,104	296	75	75	1 64	1 09	4,752,838	9	269	8,400
18 Pennsylvania	1	44,596,853	1,579	1,464	108	70	70	1 50	1 00	261,807	8	21	338
19 Tennessee	167	2,204,323	140	140	1	78	78	2 75	1 40	27,720	6	1	10
20 Texas	18	40,000	20	25	66	65	65	1 50	82	2,035	2	2	11
21 Vermont	1	20,000	1,221	1,153	14	70	70	1 55	1 09	255,986	10	31	287
22 Virginia	20	3,413,000	893	879	853	76	76	1 91	1 19	240,158	8	11	819
23 West Virginia	12	2,142,218	853	853	853	76	76	1 91	1 19	357,354	10	14	478
24 Wisconsin	8	90,000	90,000	90,000	90,000	76	76	1 91	1 19	357,354	10	2	18
25 Utah Territory	2	90,000	90,000	90,000	90,000	76	76	1 91	1 19	357,354	10	2	18

† The furnaces in North Carolina and Utah were not in operation in the census year.

*Repairing.

STATISTICS OF PRODUCTION, 1879-'80.

11

OF THE UNITED STATES.

MATERIALS.									
Tons of iron ore.	Value.	Tons of fluxing material.	Value.	Bushels of charcoal.	Value.	Tons of anthracite coal.	Value.	Tons of raw bituminous coal.	Value.
7,256,684	\$38,205,278	3,169,149	\$2,547,336	53,909,823	\$3,679,120	2,615,182	\$8,012,755	1,051,753	\$2,095,887
142,286	138,646	29,902	27,087	4,340,338	244,989	.....	.....	7,000	10,500
46,147	242,548	7,573	3,927	2,134,162	222,902	.....	.....	.....	.....
61,194	97,997	5,863	4,211	764,340	33,838	.....	.....	1,000	2,000
150,540	924,750	53,725	61,000	.....	.....	11,205	65,249	27,715	86,220
31,744	213,458	14,600	13,205	68,000	450	.....	.....	54,100	93,450
102,667	373,474	40,104	36,553	3,053,200	141,472	.....	.....	53,215	90,499
4,253	6,387	501	3,546	211,665	12,700	.....	.....	.....	.....
136,796	465,911	51,070	30,933	3,793,420	242,356	32,600	139,000	.....	.....
21,564	83,326	4,340	3,460	540,000	54,000	5,900	23,240	.....	.....
201,179	1,162,961	9,263	15,231	11,876,221	912,882	.....	.....	.....	.....
169,982	772,012	42,519	24,704	2,160,500	150,000	1,050	6,150	21,576	59,028
314,199	1,511,942	115,592	88,774	.....	.....	225,713	779,676	.....	.....
609,642	2,315,439	135,950	157,092	2,702,687	256,467	396,804	1,252,009	120	720
953,008	5,147,695	446,811	450,987	7,879,959	484,047	2,210	11,710	638,711	1,170,089
7,846	8,788	518	2,786	371,009	21,519	.....	.....	.....	.....
3,838,455	17,720,502	1,970,931	1,460,928	4,993,919	324,757	1,921,588	5,631,922	215,729	519,768
102,656	212,780	35,412	20,940	1,084,749	62,229	.....	.....	9,000	11,250
3,240	6,480	540	2,700	240,000	14,400	.....	.....	.....	.....
1,050	8,100	100	100	70,000	5,600	.....	.....	.....	.....
40,750	81,204	6,827	4,248	1,467,390	74,143	.....	.....	.....	.....
134,538	626,758	80,156	81,442	214,500	11,415	.....	.....	4,047	4,907
182,934	1,074,120	52,072	52,542	5,939,739	407,904	18,052	103,799	14,540	47,456

TABLE I.—THE BLAST FURNACES

STATES AND TERRITORIES.	MATERIALS—Continued.						PRODUCTS.			
	Tons of coke.	Value.	Tons of other material.*	Value.	Value of all other materials.	Total value of all materials.	Tons of cold-blast charcoal pig iron.	Value.	Tons of hot-blast charcoal pig iron.	Value.
Total	2, 128, 255	\$8, 129, 240	354, 048	\$910, 667	\$39, 459	\$58, 619, 742	79, 613	\$2, 393, 175	355, 405	\$10, 080, 581
1 Alabama.....	42, 035	154, 451				575, 678	21, 057	521, 608	14, 087	329, 886
2 Connecticut.....			80	2, 000		471, 467	684	32, 148	18, 095	612, 703
3 Georgia.....	33, 650	103, 750				241, 796	6, 799	146, 340		
4 Illinois.....	101, 440	624, 490				1, 762, 009				
5 Indiana.....	1, 418	6, 143	2, 000	3, 900		335, 006			500	10, 000
6 Kentucky.....	37, 275	121, 690	29, 594	37, 722		801, 410	899	27, 952	17, 876	422, 600
7 Maine.....			52	936		23, 509	2, 015	50, 375		
8 Maryland.....	17, 600	78, 081	150	525		956, 806	1, 250	53, 500	26, 304	875, 014
9 Massachusetts.....						169, 026			5, 140	168, 760
10 Michigan.....					150	2, 091, 224			119, 500	3, 119, 835
11 Minnesota.....										
12 Missouri.....	110, 730	673, 170				1, 685, 124			19, 114	510, 000
13 New Jersey.....	17, 000	108, 278				2, 488, 670				
14 New York.....	34, 237	182, 694	104	2, 026	175	4, 166, 622	4, 470	203, 500	17, 007	599, 344
15 North Carolina.....										
16 Ohio.....	418, 624	1, 601, 300	99, 669	282, 258	634	9, 149, 620	11, 816	345, 758	41, 158	1, 023, 561
17 Oregon.....						33, 073			3, 200	78, 893
18 Pennsylvania.....	1, 054, 452	3, 563, 566	156, 223	415, 132	38, 500	29, 675, 075	21, 941	700, 099	12, 204	418, 685
19 Tennessee.....	74, 408	182, 241				489, 440	1, 825	53, 075	4, 050	134, 100
20 Texas.....						23, 580	200	6, 000	1, 200	50, 000
21 Vermont.....						13, 800			620	24, 800
22 Virginia.....	8, 753	45, 953				205, 548	6, 541	187, 025	2, 918	72, 950
23 West Virginia.....	120, 737	348, 047	30, 389	86, 042		1, 158, 611	116	5, 800	1, 200	38, 400
24 Wisconsin.....	55, 896	335, 386	35, 097	80, 126		2, 101, 393			50, 062	1 601, 100
25 Utah Territory.....										

STATISTICS OF PRODUCTION, 1879-'80.

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OF THE UNITED STATES—Continued.

PRODUCTS—Continued.										
Tons of anthracite pig iron.	Value.	Tons of bituminous coal and coke pig iron.	Value.	Tons of mixed anthracite and coke pig iron.	Value.	Tons of castings direct from furnace.	Value.	Value of other products (including jobbing and repairing).	Total tons of all products.	Total value of all products.
1, 112, 735	\$23, 545, 002	1, 515, 107	\$35, 431, 031	713, 032	\$16, 607, 985	4, 229	\$146, 236	\$1, 111, 559	3, 781, 021	\$39, 315, 509
		27, 212	551, 162					3, 200	62, 336	1, 405, 356
									18, 770	644, 911
		16, 300	311, 150					9, 400	23, 099	466, 890
		33, 618	965, 450	56, 850	1, 426, 400				95, 468	2, 391, 850
		17, 737	450, 000					535	18, 237	460, 535
		39, 240	784, 800			93	4, 800	8, 500	58, 108	1, 248, 052
								10, 000	2, 015	60, 875
2, 500	64, 500	3, 490	83, 250	26, 100	590, 000	20	1, 000	32, 175	59, 664	1, 700, 339
4, 403	132, 060							12, 000	9, 543	312, 810
						86	3, 410	21, 817	119, 586	3, 145, 062
		75, 936	1, 636, 780					73, 237	95, 050	2, 275, 017
*116, 443	2, 443, 544			40, 891	964, 710	80	2, 400	18, 084	157, 414	3, 428, 747
172, 980	3, 243, 192			118, 849	2, 649, 453	62	1, 800	118, 892	313, 368	6, 816, 241
		494, 727	11, 406, 297			1, 011	32, 675	129, 907	548, 712	13, 038, 193
									3, 200	78, 393
816, 409	17, 661, 706	†673, 836	16, 735, 001	†403, 704	9, 288, 953	2, 217	75, 579	633, 722	1, 930, 311	45, 573, 750
		41, 258	631, 757			140	6, 000	15, 090	47, 873	840, 022
									1, 400	36, 000
									620	24, 800
		8, 326	166, 520			121	3, 200	11, 000	17, 906	440, 695
		78, 427	1, 568, 864			307	11, 232	6, 800	30, 050	1, 631, 096
				67, 538	1, 088, 455	92	4, 080	2, 200	118, 282	3, 295, 835

*Includes 3,392 tons of spiegeleisen.

†Includes 7,000 tons of spiegeleisen.

‡Includes 2,483 tons of spiegeleisen.

THE MANUFACTURE OF IRON AND STEEL.

TABLE II.—THE IRON ROLLING

STATES AND TERRITORIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.	
Total.....	324	\$89,788,199	80,183	74,422	5,659	31	21	59	\$3 30	\$1 29	\$34,004,799	9
1 Alabama.....	2	203,000	60	50	10			60	2 25	1 00	18,000	8
2 California.....	1	1,000,000	319	284	35			60	3 00	1 75	177,722	12
3 Colorado.....	1	100,000	125	125				60	4 00	1 75	7,000	4
4 Connecticut.....	8	885,000	451	433	18			63	3 02	1 25	210,463	9
5 Delaware.....	9	1,431,469	867	818	49			56	2 49	1 17	344,476	11
6 Georgia.....	2	305,000	500	475	25			60	2 50	85	102,230	12
7 Illinois.....	8	2,350,620	2,468	2,197	271			61	3 67	1 25	1,090,028	9
8 Indiana.....	9	1,828,000	1,740	1,590	150			59	3 95	1 27	810,081	11
9 Kansas.....	2	450,000	630	570	60			56	3 00	1 25	166,500	5
10 Kentucky.....	8	2,765,000	2,170	1,988	182			55	4 65	1 34	906,912	10
11 Maine.....	2	300,000	400	383	17			60	2 95	1 11	96,544	7
12 Maryland.....	5	2,145,000	1,253	1,189	64			58	3 56	1 14	546,974	11
13 Massachusetts.....	22	5,751,408	5,985	5,889	125	21		58	2 70	1 21	2,343,391	10
14 Michigan.....	2	671,000	925	918	7			60	3 25	1 25	360,727	12
15 Missouri.....	6	1,670,000	855	794	61			60	5 16	1 54	389,846	10
16 Nebraska.....	1	100,000	100	90	10			60	3 00	1 50	50,000	10
17 New Hampshire.....	1	400,000	250	250				60	2 25	1 13	100,000	12
18 New Jersey.....	14	4,000,550	2,820	2,763	57			57	2 78	1 22	1,086,375	9
19 New York.....	23	6,086,000	5,532	4,995	537			59	2 93	1 22	1,937,319	8
20 Ohio.....	44	9,210,270	10,266	9,572	679	15		59	3 87	1 32	5,030,552	9
21 Pennsylvania.....	131	42,089,488	34,998	32,392	2,590	10	6	59	3 03	1 17	15,372,943	10
22 Rhode Island.....	2	550,000	275	200	75			60	4 00	1 17	130,969	10
23 Tennessee.....	4	1,201,000	1,280	1,095	185			61	3 24	99	336,786	10
24 Vermont*.....												
25 Virginia.....	5	838,000	1,134	1,084	50			59	2 45	1 13	352,539	8
26 West Virginia.....	8	2,390,191	3,228	2,901	327			56	4 62	1 30	1,301,658	6
27 Wisconsin.....	1	700,000	1,360	1,235	65			66	3 65	1 25	647,577	9
28 District of Columbia.....	1	89,600	18	18				54	2 50	1 62	7,528	6
29 Utah Territory.....	1	60,000										
30 Wyoming Territory.....	1	212,603	184	174	10			60	4 00	2 00	79,650	9

* The rolling mill in Vermont is properly an open-hearth steel works, and its statistics are included in the statistics of open-hearth steel works. It made a quantity of iron rails in the census year, however, which must be classed here.

STATISTICS OF PRODUCTION, 1879-'80.

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MILLS OF THE UNITED STATES.

MACHINES.							MATERIALS.									
Number of charcoal forge fires.	Number of single puddling furnaces.	Number of heating furnaces.	Number of hammers.	Number of trains of rolls.	Number of nail machines.	Total daily capacity, in tons of rolled iron.	Tons of iron ore.	Value.	Tons of pig iron.	Value.	Tons of old iron rails.	Value.	Tons of other old or scrap iron.	Value.	Tons of hammered iron ore blooms.	Value.
309	*4,319	2,105	239	1,206	3,775	16,430	368,959	\$2,700,167	1,574,693	\$35,898,506	708,534	\$20,701,099	422,282	\$11,180,028	14,147	\$757,704
4	2	3	6	150	600	600	15,000	200	5,000	10,000	250,000	6,300	157,000	1,700	400,412	1,986
3	18	5	4	40	332	2,690	118	3,540	756	22,680	18,669	460,412	100	1,700	400,412	1,986
5	17	25	3	18	141	3,285	20,090	12,948	299,795	9,500	285,000	11,432	301,322	1,986	84,240	84,240
5	135	33	8	28	114	780	2,837	2,063	63,787	9,128	217,943	1,355	31,346	6,930	169,840	169,840
18	13	1	8	22	701	13,105	63,470	41,414	940,607	95,869	3,611,040	6,930	169,840	12,000	324,050	324,050
90	45	2	25	164	471	5,532	57,227	28,251	599,950	49,221	1,672,398	12,000	324,050	1,000	28,000	28,000
122	55	1	27	165	255	446	6,970	51,671	26,635	553,076	20,800	589,400	24,155	685,067	1,000	65,000
25	115	57	7	38	80	67	1,097	8,973	3,227	86,703	4,592	127,150	2,739	72,656	250	15,000
20	15	5	25	285	3,825	22,930	26,755	650,536	10,350	360,350	12,855	277,845	44,649	1,177,617	687	38,700
96	52	24	88	705	800	18,035	125,181	48,623	1,099,959	24,855	690,584	15,507	517,745	15,935	454,260	454,260
40	161	189	7	10	180	3,000	15,000	8,960	204,000	9,110	309,165	15,507	517,745	2,400	84,000	84,000
16	13	28	11	16	176	873	9,900	2,775	59,870	1,200	49,200	18,000	2,400	58,800	2,100	58,800
9	85	28	1	22	15	20	15,455	89,843	43,446	922,561	17,389	480,005	21,696	596,150	1,550	75,000
7	19	12	3	44	337	511	43,962	169,248	102,494	1,980,665	49,899	1,374,338	21,581	525,804	167	9,029
24	125	68	11	81	45	950	50,791	460,208	237,231	6,043,085	85,713	2,450,640	48,002	1,109,884	8,507	470,785
14	242	141	15	81	45	950	50,791	460,208	237,231	6,043,085	85,713	2,450,640	48,002	1,109,884	8,507	470,785
26	1650	281	32	183	420	2,493	7,189	178,074	1,469,246	881,008	19,818,759	182,229	5,213,258	128,404	3,464,705	8,507
182	\$2,224	870	84	515	1,259	7,189	178,074	1,469,246	881,008	19,818,759	182,229	5,213,258	128,404	3,464,705	8,507	470,785
11	32	9	66	56	170	3,820	8,750	13,100	273,500	11,960	303,526	1,700	41,974	75,000	3,075	84,431
49	18	2	12	74	249	1,690	11,671	11,485	261,031	27,541	738,146	3,075	84,431	1,030	37,475	37,475
4	28	3	19	81	382	13,233	119,682	64,740	1,657,571	9,124	265,128	7,850	196,250	17,920	358,400	358,400
6	55	31	26	7	450	4	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568
179	31	26	7	450	4	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049
30	26	1	7	450	4	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049
2	2	1	4	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049
10	1	2	65	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049	353,568	11,049

*Excluding puddling machines, and counting each double puddling furnace as two furnaces.

†And 1 Sellers rotary puddling machine.
‡And 9 Danks puddling machines.

§ And 10 Danks puddling machines.
|| No value attached.

THE MANUFACTURE OF IRON AND STEEL.

TABLE II.—THE IRON ROLLING MILLS

STATES AND TERRITORIES.		MATERIALS—Continued.									
		Tons of hammered pig or scrap blooms.	Value.	Tons of purchased muck bar.	Value.	Bushels of charcoal.	Value.	Tons of anthracite coal.	Value.	Tons of bituminous coal.	Value.
Total		46,861	\$2,332,329	53,754	\$2,369,544	2,569,756	\$225,306	526,126	\$1,358,077	3,915,377	\$9,047,054
1	Alabama									3,000	4,800
2	California			1,000	45,000			500	5,000	10,500	78,500
3	Colorado									5,000	20,000
4	Connecticut			887	13,545	90,000	9,000			18,477	83,085
5	Delaware	416	14,523	908	45,543	65,139	5,957	4,829	18,193	35,058	116,530
6	Georgia									17,032	55,358
7	Illinois									177,260	431,402
8	Indiana									150,097	270,390
9	Kansas			60	2,200	300	45			21,000	69,750
10	Kentucky	2,665	142,375			155,000	13,683			104,848	238,210
11	Maine	40	1,520					275	1,450	11,173	55,865
12	Maryland	6,686	283,960	109	6,203			2,630	13,600	76,860	183,378
13	Massachusetts	2,186	87,490	3,500	250,000	581,736	40,903	35,450	157,357	141,215	662,177
14	Michigan					50,000	3,750	167	857	45,214	137,001
15	Missouri			200	8,000	81,000	8,505			55,402	137,531
16	Nebraska									2,500	12,500
17	New Hampshire									11,300	73,450
18	New Jersey			2,800	112,000	439,650	40,692	76,560	269,614	55,370	241,024
19	New York	5,192	301,921	191	6,306	59,000	4,800	11,917	32,374	224,722	677,189
20	Ohio	831	21,802	3,530	153,600	220,000	20,350			613,105	1,125,322
21	Pennsylvania	28,845	1,528,738	40,218	1,703,691	827,431	77,571	393,348	856,980	1,807,267	3,726,605
22	Rhode Island			761	22,256					10,800	44,896
23	Tennessee			30	1,200					53,780	94,235
24	Vermont										
25	Virginia							450	2,050	29,292	90,704
26	West Virginia					500	50			161,191	152,418
27	Wisconsin									63,675	206,944
28	District of Columbia									790	2,264
29	Utah Territory										
30	Wyoming Territory									10,499	50,000

OF THE UNITED STATES—Continued.

MATERIALS—Continued.				PRODUCTS.									
Tons of coke.	Value.	Value of all other materials.	Total value of all materials.	Tons of bar iron.*	Value.*	Tons of rod iron.*	Value.*	Tons of structural iron.	Value.	Tons of skelp iron.†	Value.†	Tons of rolled-iron car-axes.	Value.
14, 884	\$48, 589	\$1, 698, 880	\$88, 277, 233	663, 211	\$35, 302, 431	145, 620	\$0, 803, 133	90, 810	\$5, 520, 719	128, 321	\$7, 910, 400	2, 030	\$179, 154
			25, 400	150	10, 000								
			535, 500	8, 000	480, 000								
			131, 700										
		3, 356	612, 308	6, 305	300, 275	9, 838	631, 682						
		22, 855	1, 214, 050	15, 650	989, 000			2, 200	143, 000	1, 987	140, 050		
140	525	1, 480	873, 270	2, 828	134, 136								
		3, 080	4, 026, 099	28, 656	1, 063, 521								
86	252	32, 700	2, 957, 467	10, 993	798, 000	1, 700	100, 000						
100	1, 250		734, 245	450	2, 500	15	800						
		66, 120	2, 404, 614	10, 253	984, 571	4, 341	238, 611	2, 000	180, 000				
		2, 565	356, 942	4, 652	282, 045					1, 600	120, 000		
20	40	15, 200	1, 829, 042	18, 418	740, 900	2, 107	119, 185	300	15, 000	3, 910	249, 153		
3, 545	10, 410	538, 830	4, 879, 149	18, 855	977, 084	22, 097	1, 847, 953			5, 563	384, 513		
105	588		1, 188, 196	12, 605	672, 175								
692	3, 125	70, 000	800, 301	5, 400	319, 053								
			114, 500										
			265, 250	2, 832	172, 000								
506	2, 680	23, 200	2, 778, 069	15, 998	825, 027	5, 600	461, 000	20, 490	1, 276, 503	1, 650	125, 000		
		148, 514	5, 286, 059	90, 304	4, 786, 174	7, 015	472, 548	2, 467	150, 795	1, 921	102, 510		
110	235	55, 883	11, 450, 038	115, 049	5, 986, 599	11, 651	676, 560	485	35, 100	1, 000	50, 000		
9, 520	29, 484	519, 086	38, 879, 358	232, 899	12, 335, 625	74, 983	4, 456, 149	68, 868	3, 770, 321	110, 690	6, 739, 173	2, 330	158, 154
			375, 347										
			723, 215	3, 022	151, 100	4, 000	220, 000						
			75, 000										
		11, 005	1, 190, 698	12, 519	618, 596	1, 460	73, 000					300	21, 000
		93, 690	2, 326, 014	4, 040	222, 520	160	4, 600						
			1, 729, 274	31, 101	1, 866, 060								
			2, 264	226	9, 020								
			403, 568	350	19, 250	19	1, 045						

* These quantities and values only include bar iron and rod iron sold in the form of bars and rods; they do not include bar iron and rod iron worked into spikes and other finished forms by the same establishments, the quantities and values of which are found under the head of "other finished products," on page 29.

† Skelp iron is used for wrought iron tubes and pipes. These quantities and values do not include finished pipe made in the same works, which finished pipe is embraced in "other finished products."

TABLE II.—THE IRON ROLLING MILLS

STATES AND TERRITORIES.		PRODUCTS—Continued.									
		Tons of hammered-iron car-axles.*	Value.	Tons of iron rails.	Value.	Tons of muck bar produced for sale.	Value.	Tons of sheet iron.	Value.	Tons of boiler-plate iron.	Value.
Total		21, 884	\$1, 600, 104	466, 917	\$20, 978, 697	64, 469	\$2, 440, 941	94, 002	\$8, 478, 642	80, 560	\$6, 501, 298
1	Alabama.....										
2	California.....			6, 000	300, 000						
3	Colorado.....			4, 500	225, 000						
4	Connecticut.....										
5	Delaware.....							5, 243	481, 924	1, 241	111, 600
6	Georgia.....			8, 673	352, 024						
7	Illinois.....			72, 802	3, 192, 178						
8	Indiana.....			38, 600	1, 946, 500			6, 883	427, 320	54	3, 270
9	Kansas.....			13, 500	709, 700						
10	Kentucky.....			18, 000	800, 000			4, 784	364, 795	5, 375	507, 500
11	Maine.....										
12	Maryland.....			9, 280	431, 814			3, 178	317, 800	6, 612	426, 236
13	Massachusetts.....	50	4, 000	5, 600	308, 000					1, 870	165, 846
14	Michigan.....	4, 600	322, 000					1, 300	92, 718	4, 600	357, 158
15	Missouri.....	6, 675	521, 110								
16	Nebraska.....										
17	New Hampshire.....	1, 320	88, 440							100	6, 700
18	New Jersey.....							1, 150	101, 200		
19	New York.....	511	41, 000	34, 305	1, 508, 839	3, 510	175, 500				
20	Ohio.....	1, 803	91, 377	41, 838	1, 907, 244	5, 954	224, 890	14, 440	1, 137, 935	9, 180	584, 100
21	Pennsylvania.....	6, 925	532, 177	157, 213	6, 559, 920	53, 014	1, 984, 755	54, 174	5, 249, 950	60, 519	4, 338, 798
22	Rhode Island.....										
23	Tennessee.....			12, 800	640, 000	100	2, 900				
24	Vermont.....			1, 500	60, 000						
25	Virginia.....										
26	West Virginia.....			3, 333	147, 332	1, 891	52, 896	4, 340	300, 000		
27	Wisconsin.....			29, 552	1, 418, 496						
28	District of Columbia.....										
29	Utah Territory.....										
30	Wyoming Territory.....			9, 421	471, 050						

* This column only includes the car axles hammered in forges attached to rolling mills, and does not profess to give the total production of hammered axles in the country, a considerable quantity being made by forging establishments the statistics of which do not belong to iron rolling mill statistics.

STATISTICS OF PRODUCTION, 1879-'80.

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OF THE UNITED STATES—Continued.

PRODUCTS—Continued.														
Tons of all other plate iron, except nail plate.	Value.	Tons of hoop iron.	Value.	Tons of all other rolled iron.*	Value.	Tons of all other hammered iron.†	Value.	Tons of cut nails.‡	Value.	Tons of all other finished products.§	Value.	Value of all other products (including repairing).	Total tons of all products.	Total value of all products.
94,749	\$5,688,863	96,843	\$6,060,484	48,345	\$2,867,872	3,703	\$294,010	252,830	\$16,295,300	82,358	\$5,974,405	\$1,398,112	2,853,248	\$136,798,574
		500	37,500										650	47,500
													14,000	780,000
													4,500	225,000
												14,500	16,203	952,457
2,482	186,130			1,000	118,650					3,215	225,800	933	33,918	2,847,177
													11,501	486,760
				4,466	263,908			11,127	823,452			1,000	117,051	5,944,059
								14,038	794,036	112	11,242	10,500	77,880	4,090,868
				3,350	160,800	30	2,500			1,710	103,800	24,000	19,055	1,004,100
3,155	197,350	785	52,800	100	7,000			10,500	525,000				65,293	3,807,027
		375	22,500	2,000	81,808			224	16,000				8,851	522,953
3,702	241,403	12	555							30	1,500	6,500	47,609	2,550,051
23,410	1,333,915	3,983	220,562	1,947	183,050	250	30,000	24,544	1,778,929	474	29,440	505,166	199,252	7,778,058
						26	2,509						23,130	1,446,551
						421	45,871			3,922	374,479	18,000	16,568	1,278,513
								2,000	82,000				2,000	82,000
						500	67,000					3,000	4,762	337,140
				100	7,000			14,803	954,123	6,239	789,693	17,219	66,030	4,556,765
2,750	117,692	3,077	239,218	13,049	693,250			611	40,840	4,018	253,955	115,125	103,538	8,697,446
7,050	479,000	23,149	1,397,375					36,697	2,334,490	3,798	318,600	24,500	272,094	15,247,770
52,162	3,131,423	64,722	4,077,974	21,310	1,347,486	2,477	146,139	75,200	4,842,470	34,132	2,387,746	586,101	1,071,098	62,644,368
								8,134	488,040				8,134	488,040
								5,209	107,458	250	9,092	11,000	25,381	1,232,150
													1,500	60,000
								5,082	324,320	15,815	949,500		35,176	1,986,416
		240	12,000	123	4,920			52,795	3,587,182	500	30,918	60,568	67,437	4,422,936
													60,653	3,284,556
33	1,950												264	10,970
													9,790	491,545

* Fish-plates, etc.

† This column only includes the quantity of iron hammered in forges connected with rolling mills, there being a considerable quantity of iron hammered in forging establishments the statistics of which do not belong to iron rolling mill statistics.

‡ The quantity of cut nails here given can be reduced to kegs (which are always 100 pounds in weight) by multiplying by 20.

§ Horse-shoes, railroad spikes, wire, etc.

THE MANUFACTURE OF IRON AND STEEL.

TABLE III.—THE BESSEMER AND OPEN-HEARTH

STATES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.				WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.	
Total	86	\$20,975,099	10,835	10,213	621	1	62	\$3 21	\$1 25	\$4,930,349	9
1 Connecticut*											
2 Illinois	5	2,545,000	2,281	2,187	94		64	3 51	1 34	1,230,036	9
3 Kentucky	1	30,000	15	13	2		60	5 00	1 15	1,500	2
4 Massachusetts	2	250,000	105	105			55	4 50	1 75	51,000	12
5 Missouri	1	2,200,000	934	885	49		65	2 40	1 25	57,618	2
6 New Hampshire	1	250,000	40	39	1		54	1 75	1 25	27,090	12
7 New Jersey†	1										2
8 New York	2	2,250,000	1,050	1,521	129		66	2 18	1 07	602,218	12
9 Ohio	5	1,254,105	821	725	96		62	3 06	1 34	503,421	10
10 Pennsylvania	15	11,616,894	4,754	4,513	240	1	63	2 46	1 17	2,278,266	12
11 Rhode Island ‡	1	30,000									
12 Tennessee	1	200,000	70	60	10		60	2 50	1 00	40,000	8
13 Vermont	1	300,000	165	165			72	3 85	1 15	48,000	12

STATES.	MATERIALS—Continued.									
	Tons of old steel rails and steel-rail ends.	Value.	Tons of purchased Bessemer steel ingots and blooms.	Value.	Tons of purchased open-hearth steel ingots and blooms.	Value.	Tons of scrap iron.	Value.	Tons of scrap steel.	Value.
Total	85,053	\$2,435,263	42,939	\$2,300,988	17,713	\$1,129,662	13,911	\$295,074	90,645	\$2,257,053
1 Connecticut*					1,020	72,600				
2 Illinois	25,192	610,051					2,570	57,820	20,490	584,732
3 Kentucky	50	1,500								
4 Massachusetts	1,400	35,000	15,000	900,000	2,420	193,600	540	12,140	2,600	68,500
5 Missouri	4,500	196,000	700	56,000					1,017	53,925
6 New Hampshire									1,300	39,000
7 New Jersey†	300	10,500			5,511	324,462				
8 New York	9,091	194,000	146	7,000	450	33,000			6,745	122,000
9 Ohio	11,334	440,422					2,550	61,200	1,908	58,883
10 Pennsylvania	33,586	932,790	25,493	1,273,988	8,312	506,000	8,181	162,164	55,875	1,390,018
11 Rhode Island										
12 Tennessee	200	6,000					50	1,250	50	2,000
13 Vermont			1,600	64,000			20	500		

* A crucible steel works in Connecticut manipulates open-hearth steel.

† The only open-hearth steel works in New Jersey is so interwoven with a crucible steel works that it is not possible to separate all the details.

‡ This establishment was not in operation in the census year.

STEEL WORKS OF THE UNITED STATES.

MACHINES.								MATERIALS.					
Number of Bessemer converters.	Total daily capacity, in tons of ingots.	Number of open-hearth furnaces.	Total daily capacity, in tons of ingots.	Number of heating-furnaces.	Number of trains of rolls.	Total daily capacity, in tons of rolled steel.	Number of hammers.	Tons of iron ore.	Value.	Tons of spiegeleisen and ferro-manganese.	Value.	Tons of other pig iron.	Value.
24	4,467	37	827	177	50	5,223	40	7,327	\$50,997	80,138	\$2,883,519	906,003	\$22,521,098
6	1,201	2	240	42	12	1,302	18	86	1,290	21,444	764,786	242,382	5,965,896
		1	7					70	1,050	20	1,500	125	3,700
		4	52	3	1	47		10	80	75	6,700	1,900	52,800
2	300			7	2	250	1			906	31,710	7,010	237,300
		1	19					18	180	480	4,800	1,800	72,000
		1	15					5	50	15	600	140	5,600
2	400			40	10	930	5			7,025	192,000	83,555	1,950,000
2	364	10	159	9	5	45	7	2,097	16,346	7,029	317,133	91,010	1,945,132
12	2,202	14	275	07	18	2,549	22	4,141	36,001	47,554	1,531,290	532,031	12,161,170
		1	30										
		2	10	1				200	1,000	90	8,000	4,500	90,600
		1	20	8	2	100	1	700	4,000	300	10,000	1,250	37,600

MATERIALS—Continued.

Tons of hammered iron-ore blooms.	Value.	Tons of hammered pig and scrap blooms.	Value.	Tons of anthracite coal.	Value.	Tons of bituminous coal.	Value.	Tons of coke.	Value.	Bushels of charcoal.	Value.	Value of all other materials.	Total value of all materials.
16,053	\$899,136	250	\$10,500	140,458	\$348,752	465,055	\$1,087,731	104,980	\$471,018	37,552	\$3,461	\$138,076	\$30,826,028
				830	3,907	137,403	353,125	35,423	216,830	10,000	500	20,000	72,000
50	3,000					500	1,200						8,583,937
5,250	236,200					10,000	53,090					40,000	11,950
						12,536	37,608						1,596,020
1,800	126,000			20	125	2,500	16,000						612,643
						225	1,125						258,106
				41,853	125,500	23,157	74,013	2,317	11,600	11,716	1,504	34,485	342,337
6,216	341,606					61,870	140,984	10,801	45,574			1,502	2,745,102
2,737	192,330	250	10,500	96,755	213,220	204,455	359,696	55,939	195,114	14,836	1,357	32,029	3,377,822
													18,937,662
						8,000	16,000	500	2,500			10,000	136,750
				1,060	6,000	5,000	30,000			1,000	100		152,100

TABLE IV.—THE CRUCIBLE AND MISCELLANEOUS STEEL WORKS OF THE UNITED STATES.

STATES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.				WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	MACHINES.						
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.		Number of cementing furnaces.	Number of pot holes.	Number of heating furnaces.	Number of single puddling furnaces.	Number of trains of rolls.	Number of hammers.	Daily capacity, in tons of ingots or unwrought steel.
Total	37	\$10,065,547	5,196	5,010	185	1	58	\$3 06	\$1 39	\$2,945,539	8	42	2,691	940	57	80	170	445
Connecticut	3	500,000	95	91	4	.....	58	3 13	1 38	54,747	11	1	174	7	1	5	8	14
Illinois	1	50,000	6	6	.....	.....	55	3 50	1 50	3,000	6	2	15	.....	.....	.....	2	1½
Kentucky	1	17,000	20	20	.....	.....	60	2 50	1 25	6,000	5	.....	10	.....	.....	.....	2	2
Maryland*	1	50,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	24	1	.....	.....	2	4
Massachusetts	1	50,000	25	25	.....	.....	60	2 50	1 50	5,584	4	.....	28	4	.....	1	1	2½
New Jersey	5	1,290,000	675	675	.....	.....	60	2 63	1 42	326,247	12	.....	672	54	8	13	31	46
New York	3	825,000	255	240	15	.....	58	3 58	1 25	95,054	9	2	104	17	.....	5	16	16
Ohio	2	40,000	40	40	.....	.....	60	3 50	1 50	5,940	4	.....	56	4	.....	.....	3	5
Pennsylvania	20	7,843,547	4,080	3,913	160	1	54	3 16	1 34	2,448,307	11	37	1,608	253	48	62	107	354

STATES.	MATERIALS.																	
	Tons of iron ore.	Value.	Tons of pig iron.	Value.	Tons of old iron.	Value.	Tons of old steel.	Value.	Tons of hammered iron-ore blooms.	Value.	Tons of hammered pig and scrap blooms.	Value.	Tons of Swedish billets and bars.	Value.	Tons of other billets and bars.	Value.	Bushels of charcoal.	Value.
Total	2,128	\$10,715	17,220	\$580,653	1,952	\$77,596	10,726	\$746,601	13,211	\$931,300	2,400	\$157,000	10,410	\$855,170	16,490	\$908,407	60,594	\$5,612
Connecticut	20	100	.....	.....	145	9,500	1,008	48,020	400	30,000	.....	.....	505	39,280	250	12,500	1,050	110
Illinois .....	.....	.....	.....	.....	.....	.....	100	3,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Kentucky .....	.....	.....	35	1,050	25	750	25	750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Maryland .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Massachusetts .....	.....	.....	.....	.....	.....	.....	100	3,239	50	4,250	.....	.....	.....	.....	.....	.....	.....	.....
New Jersey	240	1,600	2,000	90,000	295	8,100	3,262	147,319	1,201	72,050	1,500	91,000	995	79,057	2,855	181,740	6,412	1,017
New York .....	.....	.....	.....	.....	100	4,000	1,062	43,420	.....	.....	.....	.....	1,257	110,000	185	11,525	1,000	155
Ohio .....	.....	.....	.....	.....	20	150	474	11,830	.....	.....	.....	.....	80	6,400	.....	.....	000	55
Pennsylvania	1,868	18,015	15,101	489,603	1,307	55,096	13,695	488,583	11,560	825,000	900	60,000	7,543	611,430	13,706	702,642	51,532	4,275

STATES.	MATERIALS—Continued.								PRODUCTS.								
	Tons of anthracite coal.	Value.	Tons of bituminous coal.	Value.	Tons of coke.	Value.	Tons of other material.	Value.	Value of all other materials.	Total value of all materials.	Tons of finished crucible steel.	Value.	Tons of other products.	Value.	Value of other products (including jobbing and re-pairing).	Total tons of all products.	Total value of all products.
Total	40,392	\$163,233	224,657	\$375,470	22,791	\$62,694	30	\$3,100	\$103,715	\$5,000,332	70,319	\$10,015,511	4,950	\$628,954	\$25,793	75,275	\$10,070,268
Connecticut	6,920	32,600	2,390	12,740	.....	.....	.....	.....	.....	184,850	1,981	284,330	84	12,000	3,000	2,065	299,930
Illinois .....	.....	.....	.....	.....	150	1,000	.....	.....	.....	4,500	130	12,000	.....	.....	.....	130	12,000
Kentucky .....	.....	.....	140	275	500	3,000	.....	.....	.....	5,825	75	9,000	.....	.....	.....	75	9,000
Maryland .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Massachusetts	480	2,514	200	1,200	.....	.....	.....	.....	.....	11,203	140	21,993	.....	.....	.....	140	21,993
New Jersey	18,600	71,875	10,510	48,499	360	1,507	.....	.....	200	793,964	10,189	1,508,350	1,000	100,000	4,500	11,189	1,612,850
New York	3,512	15,304	7,100	24,340	150	900	20	2,400	11,381	232,425	2,511	425,140	.....	.....	.....	2,511	425,140
Ohio .....	.....	.....	1,100	2,000	.....	.....	.....	.....	.....	20,485	360	35,600	.....	.....	.....	360	35,600
Pennsylvania	10,980	45,940	203,217	280,416	21,031	56,287	10	700	97,134	3,747,130	54,933	7,719,098	3,872	516,354	18,293	58,805	8,253,745

* This establishment was not in operation in the census year.

THE MANUFACTURE OF IRON AND STEEL.

TABLE V.—THE FORGES AND BLOOMARIES OF THE UNITED STATES.

STATES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.				WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	MACHINES.		
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.		Number of charcoal forge fires.	Number of hammers.	Daily capacity, in tons of blooms.
Total	118	\$4,395,963	2,939	2,875	61	3	02	\$2 25	\$0 97	\$615,395	8	495*	141	520
Georgia.....	3	11,800	49	49	.....	.....	02	3 63	75	5,835	9	6	3	5
Maryland.....	1	60,000	67	66	1	.....	55	2 12	1 00	18,138	12	18	2	24
Massachusetts.....	1	5,000	8	8	.....	.....	00	3 00	1 20	564	4	2	1	2
Missouri.....	3	228,000	165	150	15	.....	08	2 50	1 25	60,000	10	27	6	29
New Jersey.....	7	114,000	123	123	.....	.....	58	2 24	1 10	30,187	7	28	7	43
New York.....	22	2,254,000	1,489	1,460	29	.....	66	2 48	1 14	471,331	10	141	31	174
North Carolina.....	15	289,400	63	63	.....	.....	73	1 25	54	7,907	7	28	12	9
Ohio.....	1	30,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	8	1	4
Pennsylvania.....	33	1,158,000	660	655	5	.....	02	2 43	1 11	243,436	9	150*	30	188
Tennessee.....	20	76,450	148	139	6	3	63	1 11	00	21,090	0	42	25	7
Vermont.....	2	90,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	7	2	8
Virginia.....	10	78,713	167	162	5	.....	57	1 75	87	56,907	6	29	12	27

STATES.	MATERIALS.													
	Tons of iron ore.	Value.	Tons of pig iron.	Value.	Tons of scrap iron.	Value.	Bushels of charcoal.	Value.	Tons of anthracite coal.	Value.	Tons of bituminous coal.	Value.	Tons of coke.	Value.
Total	79,610	\$531,540	38,113	\$945,375	8,933	\$215,576	13,014,361	\$812,615	340	\$1,220	1,613	\$4,298	6,695	\$31,241
Georgia.....	200	1,040	.....	.....	675	12,150	67,800	3,445	.....	.....	.....	.....	.....	.....
Maryland.....	.....	.....	3,313	65,072	1,080	18,500	210,000	14,254	.....	.....	.....	.....	400	3,800
Massachusetts.....	.....	.....	.....	.....	57	1,234	7,060	600	.....	.....	.....	.....	.....	.....
Missouri.....	8,000	30,000	.....	.....	.....	.....	800,000	70,000	.....	.....	500	1,500	.....	.....
New Jersey.....	1,040	9,600	78	1,850	4,488	116,438	264,703	23,476	200	800	3	20	25	150
New York.....	65,304	428,499	20	650	163	4,130	8,736,679	531,202	.....	.....	.....	.....	.....	.....
North Carolina.....	1,355	3,510	.....	.....	.....	.....	248,784	8,282	.....	.....	.....	.....	.....	.....
Ohio.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pennsylvania.....	772	3,083	31,265	802,663	2,436	62,310	1,850,520	125,810	140	420	990	2,578	6,270	27,282
Tennessee.....	2,318	4,941	377	8,540	1	10	429,100	12,963	.....	.....	120	200	.....	.....
Vermont.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Virginia.....	561	927	3,060	66,600	33	795	399,825	22,588	.....	.....	.....	.....	.....	.....

STATES.	MATERIALS—Continued.				PRODUCTS.						
	Barrels of oil.	Value.	Value of all other materials.	Total value of all materials.	Tons of blooms and bar iron made from ore.	Value.	Tons of blooms made from pig and scrap iron.	Value.	Value of all other products (including jobbing and repairing).	Total tons of all products.	Total value of all products.
Total	853	\$900	\$4,150	\$2,540,915	37,638	\$1,812,380	34,924	\$2,129,933	\$25,761	72,557	\$3,968,074
Georgia.....	16,635	102	10,200	450	27,000	.....	552	37,200
Maryland.....	1,100	102,726	.....	.....	3,661	219,660	.....	3,661	219,660
Massachusetts.....	1,834	.....	.....	44	2,200	.....	44	2,200
Missouri.....	151,500	4,000	200,000	.....	.....	.....	4,000	200,000
New Jersey.....	300	152,643	523	29,650	8,800	177,945	1,500	3,820	200,095
New York.....	964,421	31,580	1,462,456	138	8,320	7,580	31,718	1,478,356
North Carolina.....	11,792	439	41,010	.....	.....	75	489	41,085
Ohio.....
Pennsylvania.....	853	900	2,750	1,027,805	175	16,258	24,398	1,527,008	13,543	24,573	1,556,809
Tennessee.....	26,654	756	46,786	345	16,800	1,195	1,101	64,781
Vermont.....
Virginia.....	90,005	58	6,020	2,682	151,000	1,868	2,640	158,888

* And 1 Siemens rotator.

† This establishment was not in operation in the census year.

TABLE VI.—GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY STATES.

STATES AND TERRITORIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Total	1,005	\$230,971,884	140,978	133,208	7,709	45	21	65	\$2 50	\$1 24	\$55,476,785	9	\$191,271,150	\$296,557,085	7,295,140
Alabama	14	3,809,100	1,026	1,581	45	.....	.....	74	2 27	1 14	571,713	10	601,073	1,452,856	62,986
California	1	1,000,000	310	284	35	.....	.....	60	3 00	1 75	177,722	12	535,500	780,000	14,000
Colorado	1	100,000	125	125	.....	.....	.....	80	4 00	1 75	7,000	4	181,700	225,000	4,500
Connecticut	10	2,682,000	685	663	22	.....	.....	64	2 74	1 27	331,184	10	1,341,225	1,908,008	38,061
Delaware	9	1,431,400	867	818	40	.....	.....	56	2 49	1 17	344,476	11	1,214,050	2,347,177	33,918
Georgia	14	1,135,900	1,303	1,266	37	.....	.....	62	2 10	85	185,480	9	631,707	900,850	35,152
Illinois	21	6,460,620	5,253	4,887	366	.....	.....	63	3 43	1 27	2,508,718	9	14,977,145	20,545,289	417,987
Indiana	12	2,283,000	2,048	1,883	165	.....	.....	67	3 21	1 23	864,921	10	3,293,073	4,551,403	96,117
Kansas	2	450,000	630	570	60	.....	.....	56	3 00	1 25	166,500	5	734,245	1,004,100	10,055
Kentucky	20	5,493,035	4,095	3,831	264	.....	.....	69	2 73	1 13	1,344,400	9	3,223,799	5,000,029	123,751
Maine	3	450,000	700	683	17	.....	.....	65	2 47	1 15	141,404	7	380,511	583,323	10,866
Maryland	23	4,962,125	2,763	2,656	107	.....	.....	72	1 90	96	905,000	8	2,888,574	4,470,050	110,934
Massachusetts	30	6,738,408	6,513	6,367	125	21	.....	60	2 71	1 27	2,576,539	9	6,657,232	10,288,921	141,321
Michigan	22	4,175,386	3,089	3,054	35	.....	.....	70	1 92	1 25	922,507	10	3,270,420	4,591,013	142,716
Minnesota	1	150,000	180	180	.....	.....	.....	60	2 00	1 50	25,275	(*)	.....	.....	.....
Missouri	22	9,152,472	3,139	2,989	150	.....	.....	69	2 74	1 27	734,575	9	3,240,558	4,660,530	125,758
Nebraska	1	100,000	100	90	10	.....	.....	60	3 00	1 50	50,000	10	114,500	82,000	2,000
New Hampshire	2	650,000	290	289	1	.....	.....	57	2 00	1 19	127,690	12	523,355	807,340	7,978
New Jersey	40	9,099,050	4,792	4,711	81	.....	.....	63	2 32	1 21	1,808,448	9	6,556,283	10,341,896	243,860
New York	89	21,543,221	11,444	10,697	747	.....	.....	68	2 43	1 18	4,099,451	9	13,305,220	22,210,219	598,300
North Carolina	20	759,400	63	63	.....	.....	.....	73	1 25	54	7,907	7	11,792	41,035	439
Ohio	134	25,141,204	20,071	18,885	1,171	15	.....	66	2 89	1 30	8,265,070	9	23,997,915	34,918,360	930,141
Oregon	1	100,000	250	247	3	.....	.....	72	3 00	1 50	40,822	9	83,073	73,303	3,200
Pennsylvania	366	107,304,782	57,952	54,637	3,297	12	6	66	2 32	1 13	25,095,850	9	92,267,030	145,576,268	3,616,068
Rhode Island	3	630,000	275	200	75	.....	.....	60	4 90	1 17	130,969	10	375,347	488,040	8,134
Tennessee	43	3,681,776	3,077	2,758	300	10	.....	67	1 62	88	659,773	7	1,376,050	2,274,203	77,100
Texas	1	40,000	140	140	.....	.....	.....	60	2 00	1 00	27,720	6	23,580	30,000	1,400
Vermont	4	410,000	191	190	1	.....	.....	75	3 30	1 28	50,035	7	240,900	392,300	6,620
Virginia	44	4,329,713	2,522	2,399	121	2	.....	61	1 73	89	665,432	7	1,496,151	2,585,909	55,722
West Virginia	20	3,913,616	4,121	3,780	341	.....	.....	66	2 26	1 10	1,541,816	7	3,484,625	6,054,032	147,487
Wisconsin	9	2,843,218	2,153	2,088	65	.....	.....	74	2 07	1 10	1,004,631	10	3,830,607	6,580,391	178,935
District of Columbia ..	1	89,000	18	18	.....	.....	.....	54	2 50	1 02	7,528	6	2,264	10,970	264
Utah Territory†	3	150,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wyoming Territory	1	212,008	184	174	10	.....	.....	60	4 00	2 00	79,650	9	403,508	401,345	9,790

* Repairing.

† Those establishments were not in operation in the census year.

THE MANUFACTURE OF IRON AND STEEL.

TABLE VII.—THE GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY COUNTIES.

ALABAMA.

COUNTIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of all products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Bibb*	2	\$104,000													
Calhoun	1	580,396	538	515	23			06	\$2 00	\$0 90	\$185,857	12	\$124,261	\$209,594	11,262
Cherokee	5	530,000	476	476				09	2 29	1 00	102,525	6	88,091	201,938	8,747
Jefferson	3	1,233,800	200	200				84	2 00	1 00	51,257	11	214,931	510,362	26,052
Shelby	2	725,000	262	240	22			09	2 58	90	172,074	10	136,190	354,962	13,725
Talladega	1	130,000	150	150				84	2 50	1 00	60,000	9	37,000	80,000	3,200

CALIFORNIA.

San Francisco	1	\$1,000,000	319	284	35			60	\$3 00	\$1 75	\$177,722	12	\$535,500	\$780,000	14,000
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COLORADO.

Arapahoe	1	\$100,000	125	125				60	\$4 00	\$1 75	\$7,000	4	\$131,700	\$225,000	4,500
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CONNECTICUT.

Fairfield	3	\$400,000	71	71				63	\$3 00	\$1 32	\$41,740	9	\$133,002	\$214,500	2,330
Hartford	4	600,000	186	167	19			60	3 13	1 25	84,758	11	300,670	489,880	6,314
Litchfield	8	1,297,000	139	139				78	1 48	1 17	65,974	8	471,467	644,911	18,779
New Haven	2	235,000	196	190				57	2 94	1 40	95,190	10	315,508	471,370	6,922
New London	2	100,000	93	90	3			62	3 13	1 20	43,613	10	119,678	178,037	3,716

DELAWARE.

Newcastle	0	\$1,431,469	807	818	49			56	\$2 49	\$1 17	\$344,476	11	\$1,214,050	\$2,347,177	33,918
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GEORGIA.

Bartow	6	\$197,100	135	135				68	\$3 07	\$0 98	\$11,585	5	\$30,800	\$68,040	1,980
Dade	1	130,000	200	192	8			60	2 00	1 00	9,000	11	173,183	282,150	14,850
Fannin	2	3,800	24	24				51	1 75	50	2,500	11	3,000	10,200	102
Floyd	2	115,000	100	100				09	1 50	90	3,271	(†)			
Fulton	1	250,000	500	475	25			60	2 50	85	102,239	12	373,276	486,700	11,501
Polk	2	440,000	344	340	4			66	1 72	88	56,894	7	51,388	143,700	6,719

ILLINOIS.

Cook	11	\$3,875,000	2,906	2,871	125			64	\$3 17	\$1 41	\$1,477,563	10	\$8,006,970	\$10,441,891	248,470
Hardin*	1	20,000													
Jackson*	1	170,000													
Marion	1	100,000	120	117	3			58	4 00	1 25	53,148	8	78,812	150,000	2,252
Saint Clair	3	450,000	625	555	70			65	3 23	1 20	231,200	6	739,325	1,207,400	26,650
Sangamon	2	845,620	800	670	130			66	3 15	1 88	309,642	7	2,223,800	2,441,974	56,492
Will	2	1,000,000	712	674	38			00	3 62	1 12	437,165	12	3,929,678	6,205,024	81,094

INDIANA.

Clay	1	\$230,000	50	50				84	\$1 75	\$1 25	\$16,610	11	\$99,981	\$150,535	5,737
Dearborn	1	350,000	270	225	45			60	4 37	1 25	100,851	12	323,435	558,300	8,601
Floyd	2	458,000	500	470	30			60	4 00	1 33	180,000	11	1,184,860	1,472,600	26,893
Marion	2	640,000	320	320				55	4 00	1 25	123,305	10	769,382	885,000	19,500
Martin	1	100,000	213	198	15			80	1 50	1 00	6,230	4	3,125	10,000	500
Putnam	1	100,000	150	125	25			60	3 50	1 25	100,000	11	123,900	253,006	4,000
Vanderburgh*	1	50,000													
Vigo	3	355,000	545	405	50			68	3 32	1 25	337,925	11	788,391	1,221,968	30,975

* These counties contain iron establishments, but they were not in operation in the census year.

† Repairing.

TABLE VII.—THE GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY COUNTIES—Continued.

KANSAS.

COUNTIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of all products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Shawnee.....	1	\$150,000	200	100	10	.....	.....	60	\$3 00	\$1 25	\$6,500	1	\$52,750	\$64,900	1,100
Wyandotte.....	1	300,000	430	380	50	.....	.....	52	3 00	1 25	160,000	9	681,495	939,200	17,955

KENTUCKY.

Bath*.....	1	\$18,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Boyd.....	4	1,415,000	000	450	150	.....	.....	63	\$3 50	\$1 14	\$255,350	10	\$597,884	\$1,074,000	37,020
Campbell.....	3	640,000	700	700	.....	.....	.....	04	3 88	1 44	805,500	12	1,359,990	2,033,950	45,785
Carter.....	3	185,000	350	320	30	.....	.....	72	1 00	1 00	98,000	7	60,750	114,000	4,000
Estill.....	2	130,000	250	250	.....	.....	.....	75	1 40	75	30,481	12	11,924	30,252	902
Greenup.....	6	1,293,035	000	850	50	.....	.....	78	1 75	1 06	163,057	10	180,702	233,600	11,376
Jefferson.....	3	392,000	470	468	2	.....	.....	60	3 24	1 32	149,187	6	305,784	514,023	7,008
Kenton.....	3	730,000	565	533	32	.....	.....	59	4 04	1 30	281,925	7	603,705	1,012,004	14,560
Lyon.....	2	500,000	200	200	.....	.....	.....	84	1 50	1 00	60,000	9	48,000	77,000	2,500
Trigg*.....	2	190,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

MAINE.

Cumberland.....	1	\$100,000	200	190	10	.....	.....	60	\$2 90	\$1 17	\$51,544	7	\$241,242	\$322,748	5,729
Piscataquis.....	1	150,000	300	300	.....	.....	.....	75	1 50	1 25	44,950	7	23,560	60,375	2,015
Washington.....	1	200,000	200	193	7	.....	.....	60	3 00	1 04	45,000	6	115,700	200,205	3,122

MARYLAND.

Alleghany.....	3	\$1,050,000	001	579	22	.....	.....	72	\$4 00	\$1 23	\$153,368	7	\$579,406	\$822,000	20,311
Baltimore.....	10	1,632,125	1,408	1,943	05	.....	.....	07	1 05	1 09	532,579	10	1,803,200	2,072,940	69,944
Cecil.....	3	550,000	310	305	5	.....	.....	65	1 03	1 08	132,157	10	322,292	637,400	9,739
Frederick.....	2	575,000	200	200	.....	.....	.....	80	1 43	87	50,000	5	112,000	185,000	6,000
Harford*.....	1	850,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Howard*.....	1	35,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Prince George's.....	1	60,000	205	190	15	.....	.....	73	1 25	80	31,300	10	47,042	86,700	2,331
Washington.....	2	110,000	39	39	.....	.....	.....	72	81	66	5,686	8	24,535	65,950	2,609

MASSACHUSETTS.

Berkshire.....	4	\$682,000	390	390	.....	.....	.....	69	\$1 88	\$1 33	\$176,000	7	\$169,026	\$312,810	9,543
Bristol.....	5	947,000	1,129	1,070	50	.....	.....	53	2 20	1 18	367,226	11	960,268	1,793,350	28,260
Essex.....	1	100,000	30	30	.....	.....	.....	60	3 00	1 00	5,500	7	70,000	108,000	1,700
Middlesex.....	1	100,000	100	100	.....	.....	.....	59	3 00	1 25	64,000	11	260,100	460,000	7,300
Norfolk.....	2	300,000	372	353	14	.....	.....	60	2 55	1 18	148,402	10	305,227	598,002	9,974
Plymouth.....	9	1,235,000	993	948	39	6	.....	61	2 57	1 17	387,315	7	1,450,324	2,120,779	27,163
Suffolk.....	5	1,024,408	1,120	1,108	12	.....	.....	54	3 88	1 60	444,095	12	1,532,002	2,189,987	27,201
Worcester.....	3	1,750,000	2,379	2,354	10	15	.....	57	2 08	1 41	984,001	7	1,688,285	2,701,993	30,180

MICHIGAN.

Antrim.....	1	\$500,000	251	251	.....	.....	.....	77	\$1 75	\$1 25	\$98,603	11	\$190,081	\$389,740	12,975
Benzie.....	1	100,000	50	50	.....	.....	.....	84	2 00	1 25	5,000	(†)	.....	.....	.....
Charlevoix*.....	1	20,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Delta.....	1	325,000	225	225	.....	.....	.....	60	1 88	1 40	100,000	12	192,510	217,650	10,851
Huron.....	1	100,000	67	64	3	.....	.....	70	1 50	1 25	2,500	(†)	.....	.....	.....
Leclenaw.....	1	45,000	130	130	.....	.....	.....	60	2 00	1 00	.....	(†)	.....	.....	.....
Marquette.....	4	880,000	470	445	25	.....	.....	65	1 87	1 42	94,541	8	450,257	633,329	25,547
Menominee.....	1	40,000	150	150	.....	.....	.....	77	2 00	1 25	60,000	11	181,000	270,000	9,000
Muskegon.....	1	150,000	200	200	.....	.....	.....	70	1 75	1 25	24,000	3	82,917	129,103	4,611
Schoolcraft*.....	1	108,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Van Buren.....	2	300,000	451	451	.....	.....	.....	70	1 75	1 13	100,967	12	300,348	453,152	16,184
Wayne.....	7	1,547,386	1,095	1,088	7	.....	.....	68	2 70	1 27	436,986	11	1,872,407	2,498,634	63,548

* These counties contain iron establishments, but they were not in operation in the census year.

† Repairing.

THE MANUFACTURE OF IRON AND STEEL.

TABLE VII.—THE GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY COUNTIES—Continued.

MINNESOTA.

COUNTIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of all products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Saint Louis	1	\$150,000	180	180	.....	.....	.....	60	\$2 00	\$1 50	\$25,275	(†)	.....	.....	.....

MISSOURI.

Crawford	2	\$400,000	700	675	25	.....	.....	72	\$2 50	\$1 18	\$54,000	10	\$275,000	\$510,000	10,114
Dent*	1	90,372	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Franklin*	1	140,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Iron*	1	1,500,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Jefferson	1	150,000	165	150	15	.....	.....	68	2 50	1 25	60,000	10	151,500	200,000	4,000
Phelps*	3	600,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Saint Francois*	1	202,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Saint Louis	10	5,000,000	2,268	2,158	110	.....	.....	67	3 23	1 39	616,575	7	2,823,058	3,950,530	102,644
Washington*	2	100,000	† 6	† 6	4,000

NEBRASKA.

Douglas	1	\$100,000	100	90	10	60	\$3 00	\$1 50	\$50,000	10	\$114,500	\$82,000	2,000
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NEW HAMPSHIRE.

Hillsborough	2	\$850,000	290	289	1	57	\$2 00	\$1 19	\$127,690	12	\$523,355	\$807,340	7,978
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NEW JERSEY.

Cumberland	1	\$500,000	311	311	55	\$2 00	\$0 95	\$124,000	11	\$292,700	\$441,000	6,181
Essex	3	600,000	281	281	.....	.....	.....	65	2 50	1 48	126,144	9	471,940	771,078	9,016
Hudson	5	1,100,000	510	498	12	.....	.....	64	2 51	1 43	245,634	12	1,044,826	1,847,687	33,247
Mercer	3	1,945,550	1,301	1,301	30	.....	.....	57	2 59	1 23	518,325	12	1,971,245	2,840,881	28,315
Morris	13	1,140,500	474	472	2	.....	.....	62	2 59	1 22	111,103	7	401,833	704,220	22,455
Passaic	5	560,000	656	656	.....	.....	.....	59	2 22	1 19	302,060	9	519,029	927,803	16,019
Sussex	2	700,000	256	249	7	.....	.....	73	1 60	1 08	106,872	12	714,515	1,130,480	50,825
Union	1	25,000	60	57	3	.....	.....	65	3 00	1 25	15,000	3	50,750	72,000	1,200
Warren	7	2,528,000	853	826	27	.....	.....	65	1 99	1 09	258,710	8	1,590,439	2,107,238	76,822

NEW YORK.

Albany	3	\$1,816,067	541	526	15	.....	.....	66	\$2 20	\$1 18	\$185,957	9	\$599,674	\$1,167,168	40,611
Cayuga	2	120,000	70	68	2	.....	.....	68	2 94	1 03	29,871	12	196,288	255,660	6,021
Chemung	2	500,000	410	404	6	.....	.....	67	2 23	1 00	182,048	12	870,541	1,124,704	30,053
Clinton	17	1,499,000	751	717	34	.....	.....	69	2 27	1 10	267,773	8	869,076	1,202,419	23,634
Columbia	4	887,462	186	186	.....	.....	.....	77	1 85	1 26	73,024	7	427,153	569,016	30,545
Dutchess	7	1,446,549	409	407	2	.....	.....	73	1 84	1 27	198,003	10	876,902	1,323,857	61,637
Erie	4	1,780,000	713	688	25	.....	.....	65	2 48	1 19	212,278	9	635,353	887,012	25,015
Essex	13	3,205,000	894	894	.....	.....	.....	67	2 05	1 18	274,853	7	1,118,007	1,867,756	66,725
Franklin	1	300,000	237	237	.....	.....	.....	66	2 50	1 25	114,885	12	128,231	213,195	4,643
Jefferson	2	70,000	40	40	.....	.....	.....	77	1 50	1 00	9,857	10	57,338	110,900	3,346
Kings	1	300,000	30	30	.....	.....	.....	60	5 00	1 50	10,000	6	47,060	135,000	450
Lewis	3	105,000	165	164	1	.....	.....	72	1 68	1 07	6,204	4	10,015	25,500	470
Monroe	1	100,000	52	50	2	.....	.....	77	2 00	1 12	17,000	10	102,560	165,000	8,250
New York	2	550,000	269	264	5	.....	.....	69	2 25	1 30	95,307	10	614,008	949,156	31,103
Niagara*	2	540,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oneida	4	673,000	552	508	44	.....	.....	65	3 73	1 54	153,749	7	874,555	919,721	21,103
Onondaga	5	1,306,000	735	685	50	.....	.....	66	1 75	1 00	271,487	11	629,141	1,268,852	24,445
Orange	3	787,493	475	439	36	.....	.....	64	2 88	1 17	189,808	11	400,017	682,570	27,548
Putnam*	1	96,750	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* These counties contain iron establishments, but they were not in operation in the census year.

† Repairing.

‡ Watchmen.

TABLE VII.—THE GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY COUNTIES—Continued.

NEW YORK—Continued.

COUNTIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of all products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Rensselaer.....	4	\$4,550,000	4,352	3,857	495	.....	.....	67	\$2 41	\$1 18	\$1,657,308	11	\$4,618,802	\$8,702,189	177,967
Rockland.....	1	110,000	80	20	19	.....	.....	60	2 50	1 25	4,700	4	12,315	23,100	275
Saint Lawrence*.....	1	15,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ulster.....	3	325,000	387	367	20	.....	.....	60	4 30	1 25	123,418	7	151,019	411,255	6,200
Washington.....	1	200,000	46	46	.....	.....	.....	77	1 30	1 13	18,470	11	141,504	200,239	7,815
Wayne.....	1	90,000	100	100	.....	.....	.....	68	1 63	1 00	2,703	1	5,900	8,900	445
Westchester*.....	1	90,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

NORTH CAROLINA.

Catawba.....	3	\$13,000	13	13	.....	.....	.....	72	\$1 25	\$0 30	\$1,500	10	\$1,680	\$4,880	61
Chatham*.....	2	370,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cherokee.....	4	15,200	33	33	.....	.....	.....	60	1 50	50	3,400	5	3,332	12,910	144
Cumberlandt.....	.....	10,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Guilford*.....	1	100,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Harnettt.....	.....	10,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Lincoln.....	4	72,700	5	5	.....	.....	.....	72	1 25	60	190	2	450	795	9
Mitchell.....	2	140,000	12	12	.....	.....	.....	88	1 00	75	2,817	0	4,850	17,000	170
Moore†.....	.....	10,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Surry‡.....	4	18,500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1,480	5,500	55

OHIO.

Athens.....	1	\$175,000	215	215	.....	.....	.....	84	\$2 00	\$1 40	\$130,000	12	\$82,000	\$230,495	8,070
Belmont.....	5	1,205,440	986	864	107	.....	15	72	3 06	1 40	518,805	11	1,458,585	2,385,090	50,193
Columbiana.....	4	400,000	768	703	55	.....	.....	69	4 04	1 27	247,271	8	837,538	1,251,084	44,110
Cuyahoga.....	10	2,839,042	2,909	2,788	211	.....	.....	67	2 58	1 20	1,960,237	9	6,491,506	9,435,432	210,354
Erie.....	1	275,000	225	220	5	.....	.....	48	3 50	1 00	7,232	2	75,000	105,000	2,000
Franklin.....	3	800,000	530	504	26	.....	.....	60	2 63	1 27	177,008	7	784,794	1,140,525	22,898
Gallia*.....	1	150,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hamilton.....	4	610,689	313	305	8	.....	.....	60	4 03	1 38	163,590	8	338,479	596,160	8,384
Hocking.....	6	1,890,000	927	923	4	.....	.....	72	1 61	1 32	135,107	5	322,447	491,965	21,415
Jackson.....	16	1,762,000	1,541	1,402	79	.....	.....	70	2 08	1 15	528,520	8	607,853	686,003	41,686
Jefferson.....	7	1,103,000	589	564	25	.....	.....	66	2 79	1 35	293,675	9	1,125,833	1,207,312	40,561
Lawrence.....	15	4,010,000	3,523	3,278	245	.....	.....	62	3 01	1 10	1,045,052	11	1,332,700	2,507,874	70,794
Lucas*.....	1	50,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Mahoning.....	13	3,781,715	2,889	2,774	115	.....	.....	67	2 75	1 27	1,320,366	10	6,066,349	7,850,278	219,857
Meigs.....	1	100,000	250	225	25	.....	.....	60	4 00	1 25	37,500	6	137,950	245,000†	4,675
Muskingum.....	2	400,000	267	256	11	.....	.....	68	2 50	1 20	174,394	11	529,044	848,018	23,147
Paulding.....	3	200,000	180	180	.....	.....	.....	70	1 40	1 25	37,000	8	88,100	122,000	5,000
Perry.....	6	913,500	605	603	2	.....	.....	74	1 91	1 40	211,427	10	438,908	644,275	34,834
Scioto.....	10	1,130,000	1,206	1,091	115	.....	.....	63	3 46	1 41	480,577	7	618,650	859,000	10,791
Stark.....	4	450,000	139	136	3	.....	.....	60	5 00	1 15	61,106	12	111,137	282,880	2,990
Summit.....	2	207,000	107	178	19	.....	.....	55	2 00	1 25	123,475	10	362,954	603,427	7,783
Trumbull.....	10	1,330,000	1,632	1,516	110	.....	.....	66	2 87	1 26	604,228	10	1,888,167	2,866,927	73,309
Tuscarawas.....	3	627,909	100	100	.....	.....	.....	65	1 74	1 10	42,500	9	288,951	890,000	15,726
Vinton*.....	5	610,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Washington*.....	1	60,000

OREGON.

Clackamas.....	1	\$100,000	250	247	3	72	\$3 00	\$1 50	\$46,822	9	\$33,073	\$78,393	3,200
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* These counties contain iron establishments, but they were not in operation in the census year.

† These counties have capital invested by iron establishments, but do not contain any works.

‡ No further statistics could be procured than are here given.

THE MANUFACTURE OF IRON AND STEEL.

TABLE VII.—THE GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY COUNTIES—Continued.

PENNSYLVANIA.

COUNTIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of all products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Adams *	1	\$13,000													
Allegheny	56	32,596,364	19,798	18,345	1,436	11	6	64	\$3 15	\$1 39	\$9,066,803	10	\$26,827,087	\$46,078,376	848,146.
Armstrong	6	690,000	445	395	50			51	4 13	1 28	235,000	12	230,265	608,513	9,300.
Beaver	2	290,000	70	76	3			60	3 52	1 27	34,942	8	107,868	149,101	1,320.
Bedford	3	678,334	120	116	4			72	1 46	1 00	40,861	12	117,691	210,667	10,396.
Berks	33	5,865,118	3,048	2,949	99			68	2 37	1 00	1,123,940	9	5,400,091	7,730,512	213,580.
Blair	16	1,796,916	1,290	1,227	63			62	2 33	1 11	409,703	9	1,390,976	2,176,362	68,039.
Bradford	1	25,000	40	40				65	2 00	1 00	4,404	2	9,327	2,700	45.
Bucks	2	430,000	378	348	30			68	3 30	1 25	124,046	11	350,046	658,887	23,605.
Cambria	4	7,500,000	2,585	2,425	160			64	2 17	1 10	1,217,680	12	6,848,300	12,672,000	260,140.
Carbon	3	530,000	223	220	3			69	1 77	88	56,437	6	507,501	732,191	28,455.
Centre	12	1,080,000	524	500	24			67	2 34	1 18	217,842	10	542,345	899,126	17,411.
Chester	12	2,159,900	1,735	1,654	81			70	2 28	1 26	812,079	9	2,050,898	4,102,957	78,363.
Clarion *	1	150,000													
Clinton *	2	160,000													
Columbia	4	575,000	424	415	9			61	1 86	1 03	153,528	9	419,105	605,644	22,121.
Crawford	1	50,000	21	21				60	3 00	1 25	10,941	7	9,917	23,827	427.
Cumberland	6	760,000	687	665	22			67	2 04	90	239,624	11	414,034	860,400	16,959.
Dauphin	16	6,368,692	2,508	2,425	83			65	2 49	1 10	976,940	10	5,714,076	8,383,390	223,670.
Delaware	3	597,895	493	485	8			54	2 78	1 29	174,795	12	388,666	590,275	9,988.
Erie	2	325,000	235	229	6			58	2 45	1 30	97,309	7	368,076	499,186	10,365.
Fayette	5	1,158,000	790	710	23			65	2 02	1 28	348,619	9	480,376	766,831	37,108.
Franklin	6	383,000	220	200	11			84	1 64	1 03	48,974	10	179,326	320,794	8,693.
Huntingdon	7	2,065,916	420	419	7			64	2 02	90	102,363	11	455,400	668,393	28,481.
Lackawanna	4	2,294,000	1,506	1,534	62			64	1 98	1 02	605,953	11	4,792,978	5,400,085	151,273.
Lancaster	18	2,407,500	1,605	1,491	114			61	2 06	1 03	444,305	8	1,757,828	2,663,223	87,019.
Lawrence	9	1,514,895	871	812	59			70	2 50	1 41	483,076	8	2,019,474	2,864,509	88,443.
Lebanon	13	1,428,628	501	488	13			68	2 14	1 03	230,134	11	1,250,411	1,904,489	73,149.
Lehigh	9	9,514,850	2,673	2,552	121			69	2 85	1 10	890,926	10	5,031,985	8,578,871	324,875.
Lycoming	4	170,000	96	92	4			58	1 63	1 00	25,700	6	47,974	104,740	1,439.
Mercer	18	2,725,284	1,977	1,812	165			69	2 90	1 32	896,485	9	3,946,881	5,832,720	182,881.
Mifflin	4	625,000	324	314	10			68	2 13	1 10	140,284	12	590,214	990,170	22,036.
Montgomery	10	5,245,613	2,973	2,927	46			68	2 36	1 20	1,301,610	9	4,593,563	7,194,821	168,628.
Montour	7	1,073,682	1,381	1,236	144	1		68	2 22	1 01	473,744	10	2,110,877	2,751,088	79,789.
Northampton	10	6,375,000	3,220	3,078	142			68	2 05	1 18	1,207,126	11	6,221,028	9,263,865	322,882.
Northumberland	5	745,000	513	490	23			72	2 28	1 06	193,949	9	446,768	724,650	16,899.
Perry	5	590,000	463	438	25			61	2 50	1 10	174,918	12	544,554	786,156	17,689.
Philadelphia	16	2,999,245	2,068	1,897	171			63	2 74	1 31	1,045,570	9	2,580,512	4,257,179	65,983.
Schuylkill	14	2,211,066	1,360	1,300	60			71	2 26	1 03	416,919	11	1,909,366	2,519,921	76,609.
Tioga	1	80,000	40	40				77	2 25	1 10	2,850	2	7,001	8,680	434.
Union	1	125,000	28	24	4			70	1 00	95	7,368	10	50,303	93,700	4,059.
Westmoreland	2	307,000	210	198	12			72	2 38	1 18	130,686	11	284,249	582,792	18,802.
York	3	225,000	35	35				72	1 40	1 10	11,505	8	54,533	100,000	4,071.

RHODE ISLAND.

Providence	3	\$630,000	275	200	75			60	\$4 00	\$1 17	\$130,969	10	\$375,347	\$488,040	8,134.
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TENNESSEE.

Carter	2	\$48,000	263	260		3		60	\$1 13	\$0 75	\$6,205	8	\$25,325	\$52,565	1,389.
Claiborne *	3	24,000													
Decatur	1	109,000	60	60				78	1 00	75	10,000	2	10,875	22,800	606.
Dickson	1	150,000	150	130	15	5		84	1 00	70	40,000	8	21,300	70,000	2,400.
Greene	3	123,000	4	4				72	90		90	4	230	900	15.
Hamilton	6	1,272,000	1,204	1,119	85			67	2 23	1 01	329,410	9	835,892	1,324,350	35,645.
Houston†		20,000													
Johnson	16	77,450	177	169	6	2		67	1 26	60	21,000	7	10,687	50,867	576.

* These counties contain iron establishments, but they were not in operation in the census year.

† This county has capital invested by an iron establishment, but does not contain any works.

TABLE VII.—THE GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY COUNTIES—Continued.

TENNESSEE—Continued.

COUNTIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of all products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Knox	1	\$230,000	225	115	110	.....	.....	60	\$3 30	\$0 05	\$78,786	10	\$142,390	\$213,250	4,181
Lawrence	1	50,000	125	120	5	.....	.....	60	1 25	95	30,000	6	2,831	4,720	236
Marion	1	210,626	148	140	8	.....	.....	75	2 50	1 00	51,457	12	184,818	305,257	17,958
Roane	2	700,000	400	370	30	.....	.....	60	2 00	1 10	70,000	12	98,250	182,500	12,000
Stewart	3	570,000	321	271	50	.....	.....	54	1 25	1 00	27,825	4	34,461	47,000	1,800
Sullivan*	1	2,700	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Unicoi*	1	1,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Wayne*	1	100,000

TEXAS.

Marion	1	\$40,000	140	140	60	\$2 00	\$1 00	\$27,720	6	\$23,580	\$36,000	1,400
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VERMONT.

Addison*	1	\$15,000
Franklin	1	300,000	165	105	72	\$3 85	\$1 15	\$48,000	12	\$227,100	\$367,500	6,000
Rutland	1	80,000	26	25	1	.....	.....	78	2 75	1 40	2,035	2	13,800	24,800	620
Windsor*	1	65,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

VIRGINIA.

Alexandria	1	\$25,000	30	30	.....	.....	.....	60	\$2 00	\$1 25	\$2,000	2	\$10,200	\$12,000	200
Alleghany	2	1,000,000	150	144	6	.....	.....	77	1 75	90	62,468	11	76,179	168,920	8,437
Amherst	1	52,000	75	75	.....	.....	.....	72	1 25	80	6,500	(†)	.....	2,000	.....
Augusta*	3	405,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7,000	.....
Bath*	1	76,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Botetourt	3	230,000	50	47	3	.....	.....	60	2 40	85	32,313	(†)	.....	.....	.....
Campbell	2	203,000	80	80	.....	.....	.....	60	2 13	1 25	16,228	6	25,807	12,500	230
Giles	1	50,000	120	120	.....	.....	.....	48	1 25	75	0,000	(†)	.....	.....	.....
Henrico	3	702,000	1,054	1,004	50	.....	.....	58	2 77	1 00	330,311	10	1,173,801	1,073,016	34,046
Lee	3	4,013	8	3	.....	.....	.....	60	2 00	1 00	107	3	074	1,688	13
Louisa*	1	30,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Page	2	580,000	250	235	15	.....	.....	65	1 60	85	80,000	11	105,068	200,450	5,073
Pulaski	2	127,300	162	162	.....	.....	.....	63	1 88	95	7,880	10	2,505	6,200	50
Rockbridge*	1	300,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rockingham*	2	50,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Scott	1	400	2	2	.....	.....	.....	50	1 00	50	20	3	151	240	4
Shenandoah	6	307,000	215	175	40	.....	.....	57	1 25	78	46,400	7	30,950	67,760	1,918
Smyth	1	25,000	60	60	.....	.....	.....	72	1 15	80	4,000	(†)	.....	.....	.....
Wythe	8	163,000	271	262	7	2	.....	57	1 84	76	64,605	8	64,726	133,325	4,851

WEST VIRGINIA.

Braxton	1	\$43,000	50	40	10	.....	.....	50	\$1 25	\$0 90	\$834	1	\$3,735	\$8,800	116
Fayette	1	250,000	57	57	.....	.....	.....	84	1 50	1 10	37,710	12	140,039	238,394	10,787
Hampshire	1	75,000	5	5	.....	.....	.....	60	.....	1 25	2,000	(†)	.....	.....	.....
Hardy	1	62,000	50	48	2	.....	.....	60	1 25	80	3,500	(†)	.....	.....	.....
Kanawha*	1	40,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Marshall	3	745,191	746	679	67	.....	.....	64	2 01	1 25	267,785	10	686,978	1,180,114	37,700
Mason	1	75,000	175	160	15	.....	.....	56	4 50	1 25	26,445	2	50,284	97,257	1,000
Ohio	7	2,214,425	2,573	2,327	246	.....	.....	72	3 72	1 41	1,098,266	10	2,472,053	4,306,567	84,767
Preston	3	159,000	430	420	1	.....	.....	64	1 45	96	93,246	8	75,536	150,400	9,107
Taylor	1	250,000	35	35	.....	.....	.....	84	1 50	1 00	12,000	8	56,000	63,500	4,010

* These counties contain iron establishments, but they were not in operation in the census year.

† Repairing.

THE MANUFACTURE OF IRON AND STEEL.

TABLE VII.—THE GRAND AGGREGATE OF THE IRON AND STEEL MANUFACTURE OF THE UNITED STATES, BY COUNTIES—Continued.

WISCONSIN.

COUNTIES.	Number of establishments.	Amount of capital (real and personal) invested in the business.	AVERAGE NUMBER OF HANDS EMPLOYED.					WAGES AND HOURS OF LABOR.				Number of months in active operation, reducing part time to full time.	Total value of all materials.	Total value of all products.	Total weight of all products (tons).
			Total hands employed.	Males above 16 years.	Males below 16 years.	Females above 15 years.	Females below 15 years.	Average number of hours of labor per week.	Average day's wages for a skilled mechanic.	Average day's wages for an ordinary laborer.	Total amount paid in wages during the year.				
Brown	2	\$350,000	425	425	.....	.....	.....	80	\$2 25	\$1 30	\$191,000	11	\$639,810	\$1,254,000	35,650
Dodge	2	935,000	70	70	.....	.....	.....	84	2 25	1 13	9,200	5	117,993	81,100	4,055
Fond du Lac*	1	75,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Milwaukee	2	1,390,000	1,535	1,470	65	.....	.....	75	2 85	1 25	763,114	11	2,927,944	4,973,011	128,191
Outagamie	1	123,218	98	98	.....	.....	.....	73	1 50	1 12	36,617	12	129,720	230,080	9,799
Sauk	1	90,000	25	25	.....	.....	.....	60	1 50	1 13	5,000	9	15,200	42,200	1,240

DISTRICT OF COLUMBIA.

Washington	1	\$89,000	18	18	54	\$2 50	\$1 62	\$7,528	6	\$2,204	\$10,970	204
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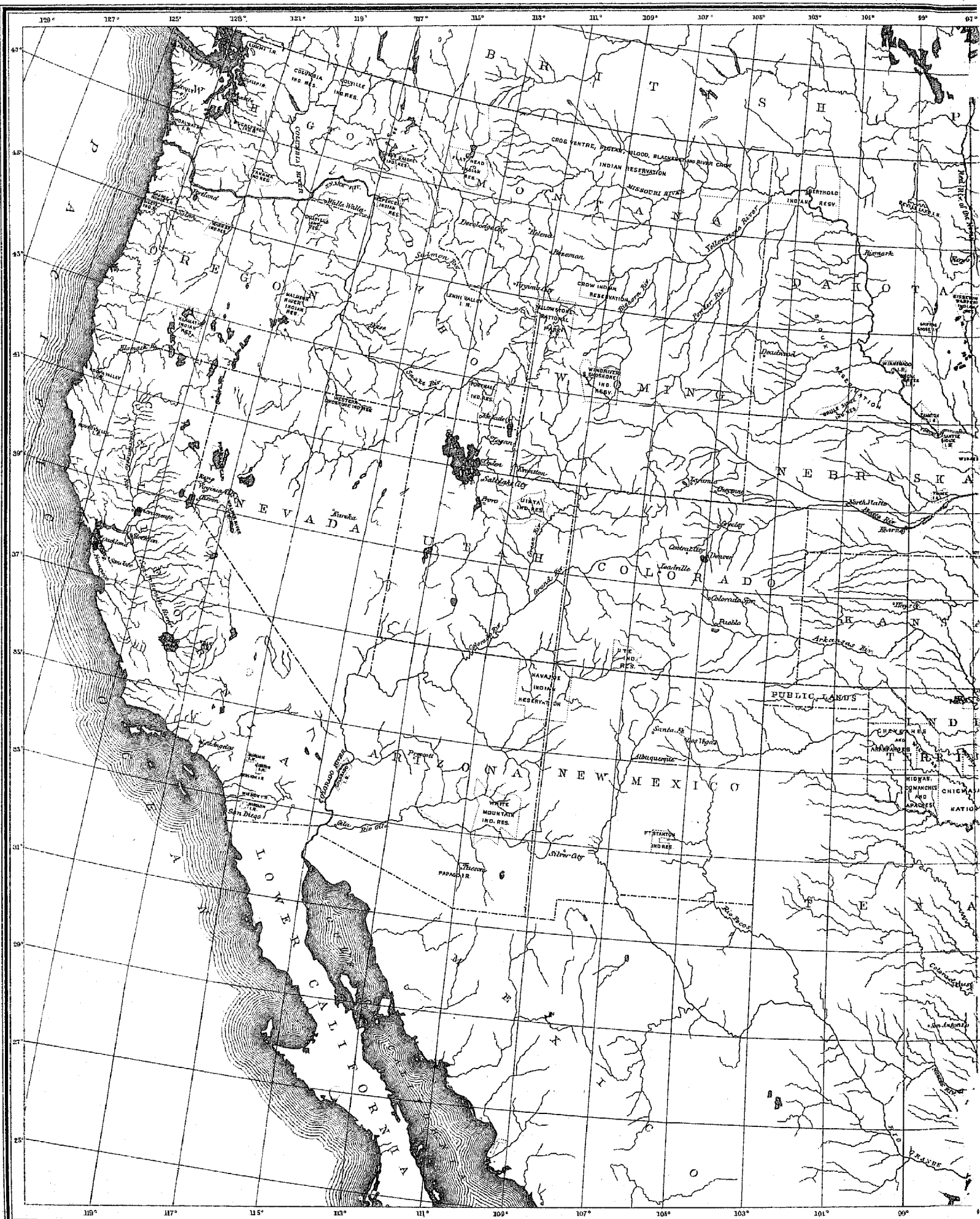
UTAH.

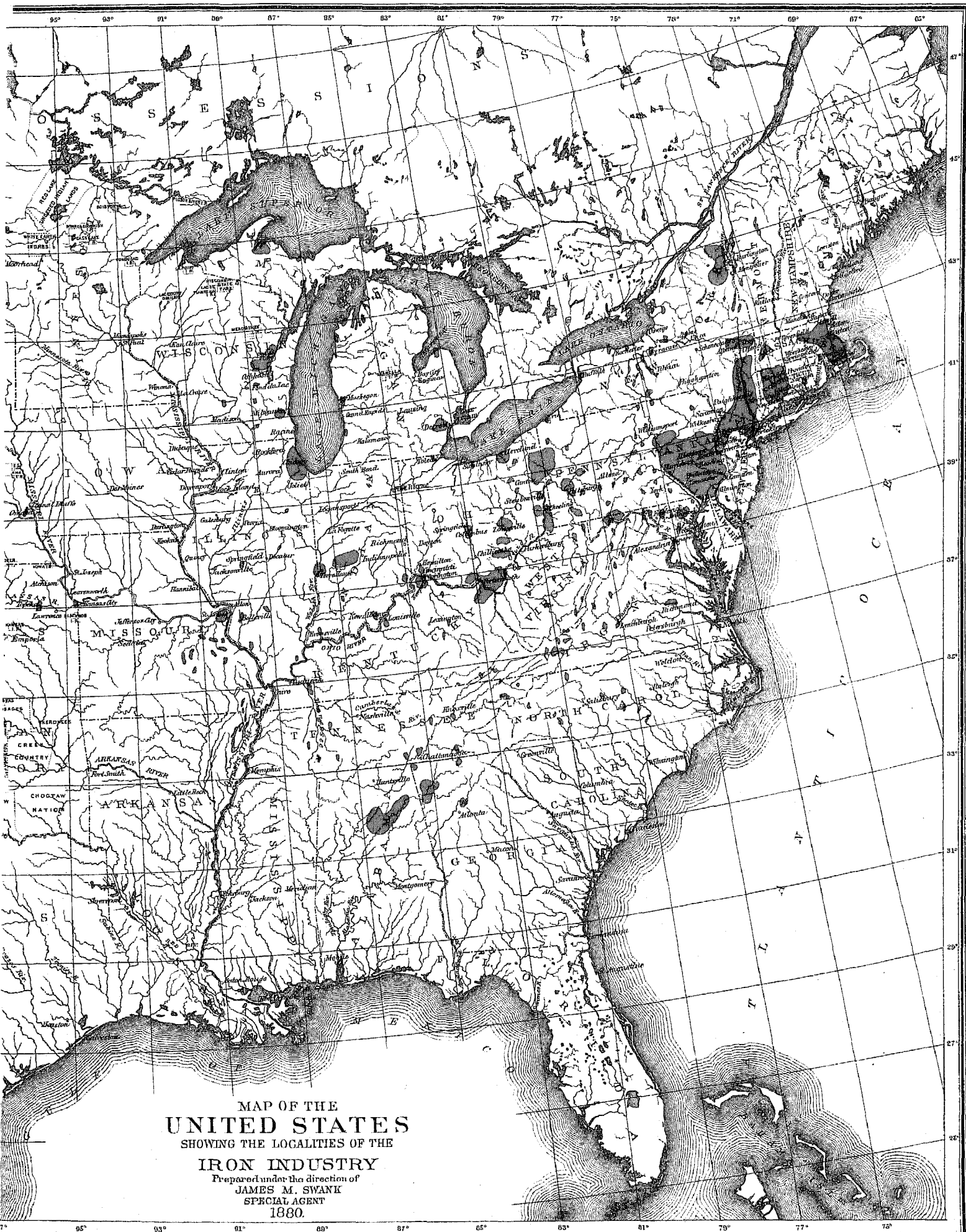
Iron*	1	\$10,000
Weber*	2	140,000

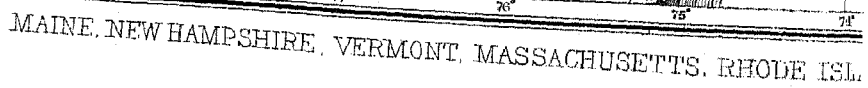
WYOMING.

Albany	1	\$212,608	184	174	10	60	\$4 00	\$2 00	\$79,050	9	\$403,568	\$491,845	9,790
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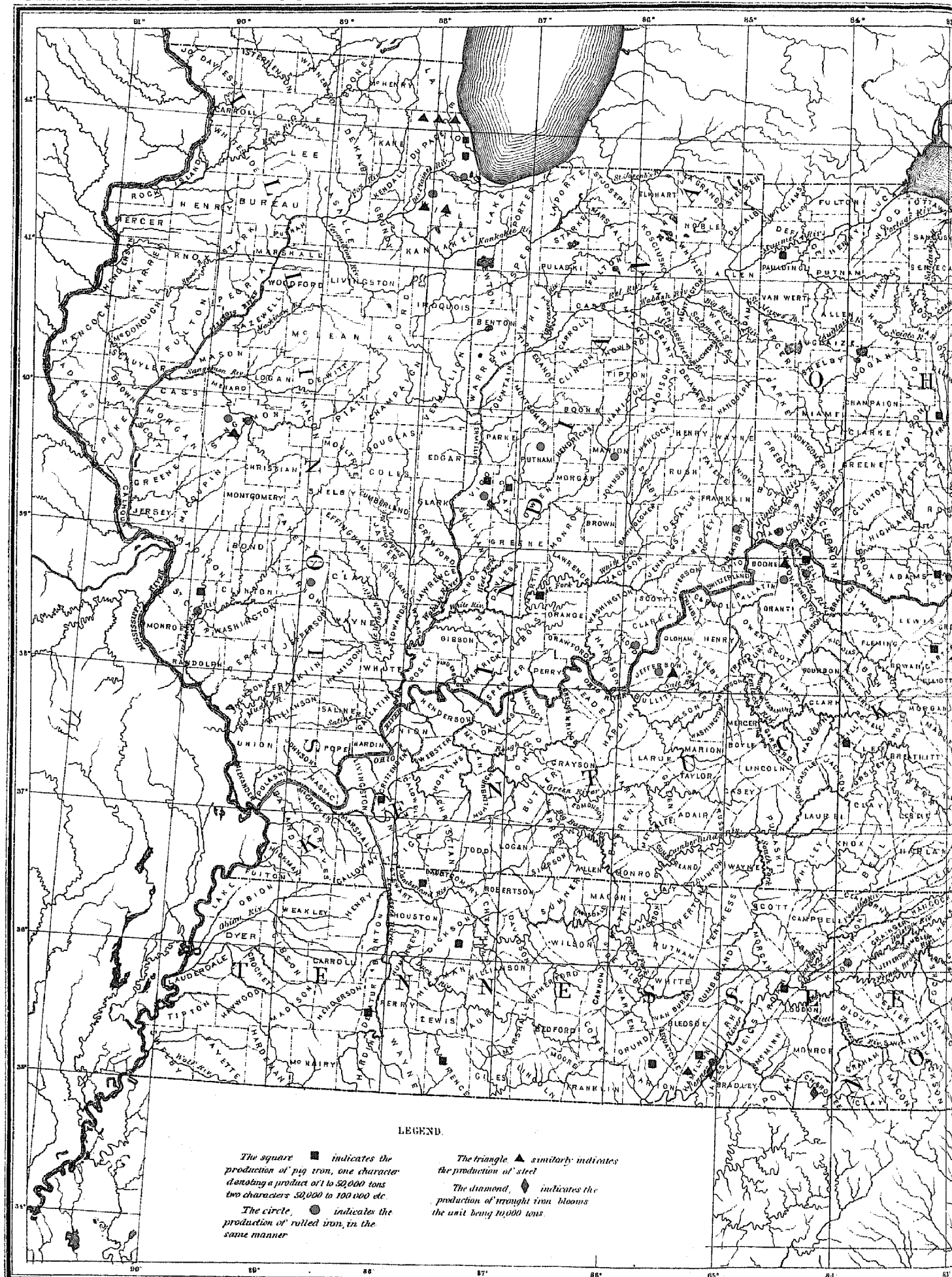
* These counties contain iron establishments, but they were not in operation in the census year.





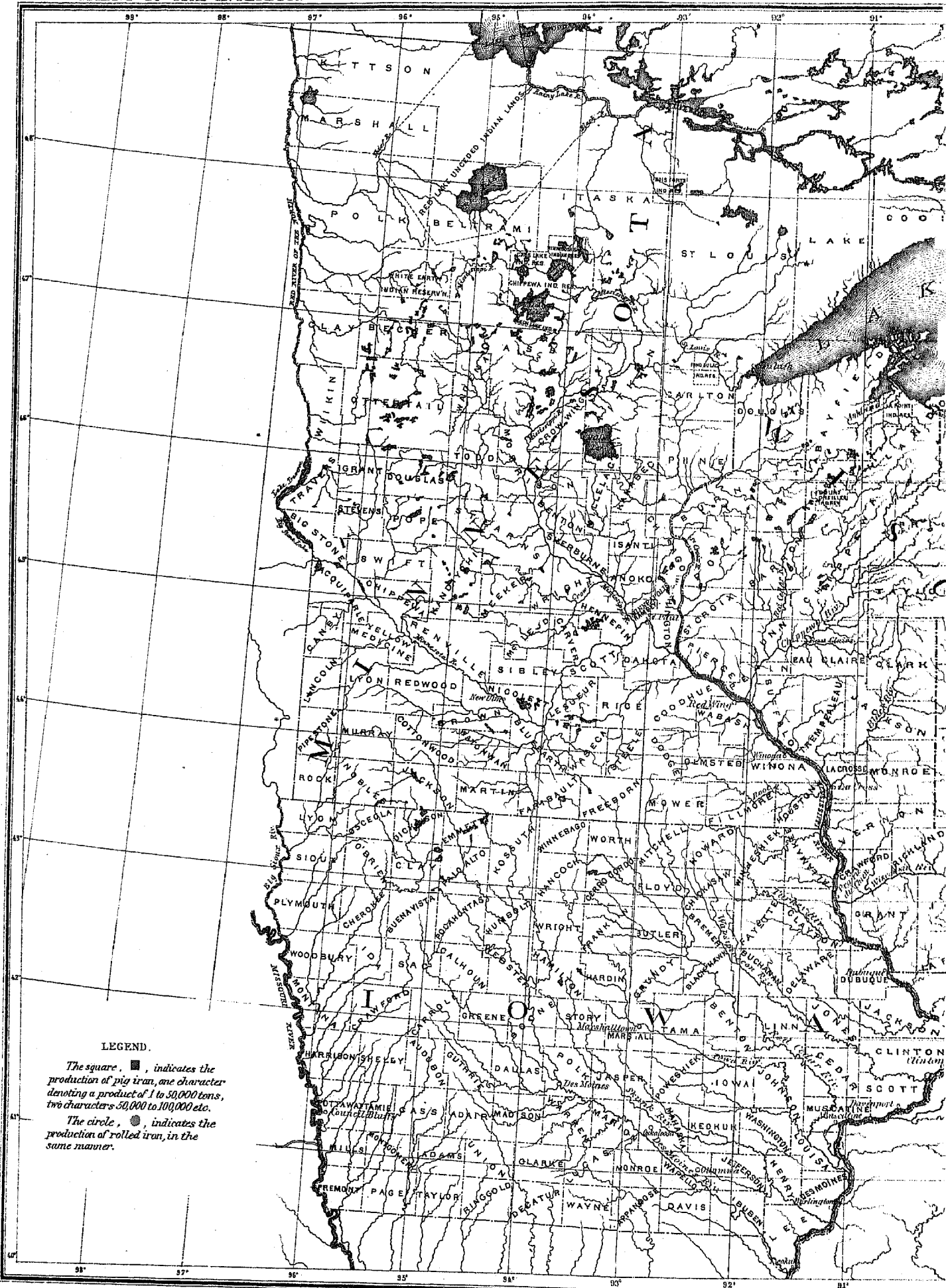








DEPARTMENT OF THE INTERIOR.



SHOWING THE QUANTITY OF
IRON & STEEL
PRODUCED IN EACH COUNTY
DURING THE CENSUS YEAR

JAMES M. SWANK

SPECIAL AGENT

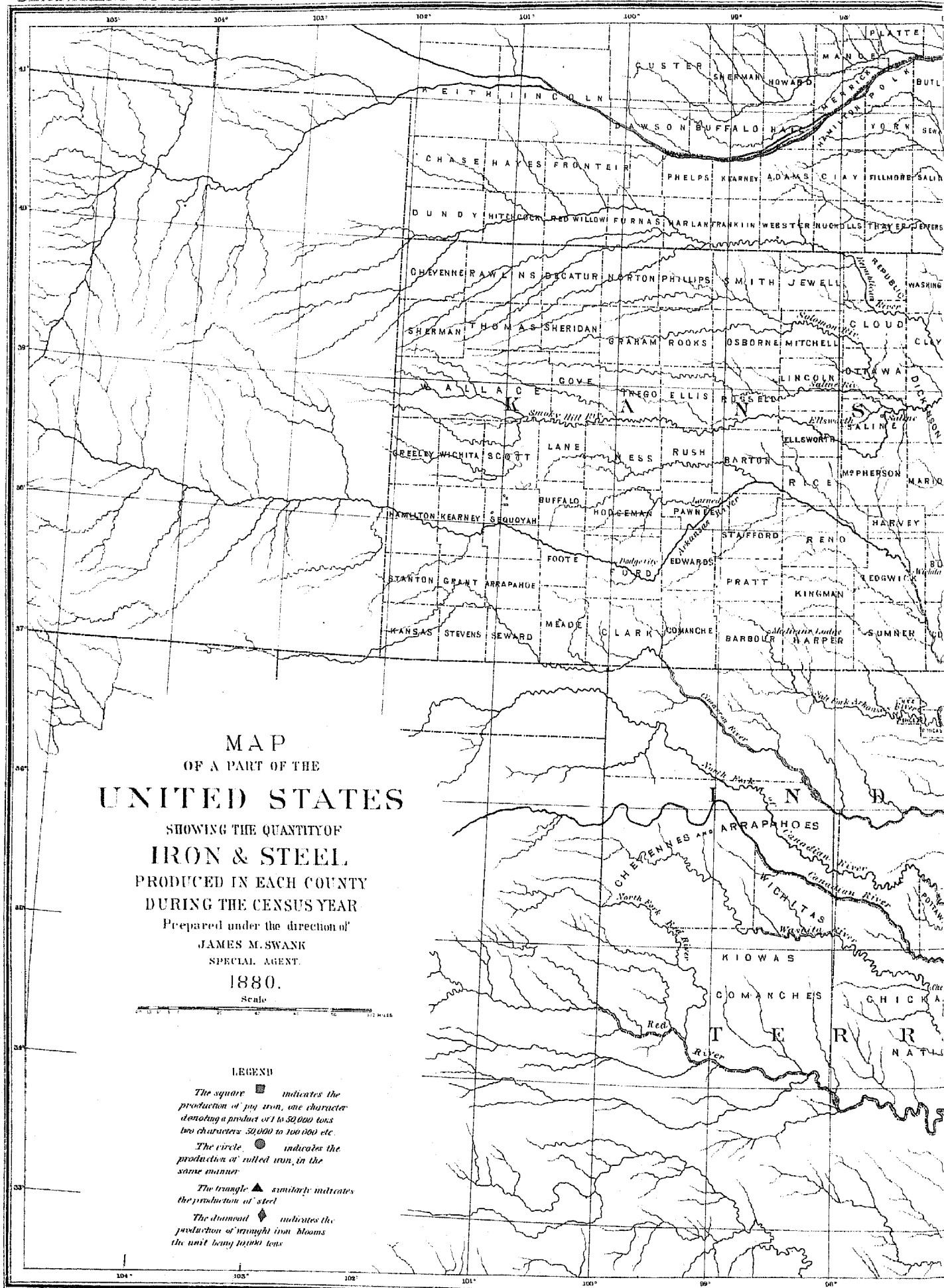
1880.

Scale











PART II.—HISTORY.

THE EARLIEST USE OF IRON.

THE use of iron can be traced to the earliest ages of antiquity. It was first used in Asia, the birthplace of the human race, and soon after the time when "men began to multiply on the face of the earth." Tubal Cain, who was born in the seventh generation from Adam, is described as "an instructor of every artificer in brass and iron." The Egyptians, whose existence as a nation probably dates from the second generation after Noah, and whose civilization is the most ancient of which we have any exact knowledge, were at an early period familiar with the use of iron, and it seems probable that they were engaged in its manufacture. Iron tools are mentioned by Herodotus as having been used in the construction of the pyramids. In the sepulchres at Thebes and Memphis, cities of such great antiquity that their origin is lost, butchers are represented as using tools which archæologists decide to have been made of iron and steel. Iron sickles are also pictured in the tombs at Memphis, and at Thebes various articles of iron have been found which are preserved by the New York Historical Society and are probably three thousand years old. Kenrick, in his *Ancient Egypt under the Pharaohs*, is authority for the statement that Thothmes the First, who reigned about seventeen centuries before Christ, is said, in a long inscription at Karnak, to have received from the chiefs, tributary kings, or allied sovereigns of Lower Egypt, presents of silver and gold, "bars of wrought metal, and vessels of copper, and of bronze, and of iron." From the region of Memphis he received wine, iron, lead, wrought metal, animals, etc. An expedition which the same king sent against Chadasha returned, bringing among the spoil "iron of the mountains, 40 cubes." Belzoni found an iron sickle under the feet of one of the sphinxes at Karnak, which is supposed to have been placed there at least six hundred years before Christ. A piece of iron was taken from an inner joint of the great pyramid at Gizeh in 1837. Both of these relics are in the British Museum. The reference to iron in Deuteronomy, iv. 20, apparently indicates that in the time of Moses the Egyptians were engaged in its manufacture, and that the Israelites, if they did not make iron for their taskmasters, were at least familiar with the art of manufacturing it. "But the Lord hath taken you, and brought you forth out of the iron furnace, even out of Egypt." This expression is repeated in I. Kings, viii. 51. A small piece of very pure iron was found under the Egyptian obelisk which has recently been removed to New York.

The use of iron and the art of manufacturing it were introduced into the southern and western portions of Arabia at a very early day, and this may have been done by the Egyptians; it is at least established that some of their own works were located east of the Red sea. In 1873 the ruins of extensive iron works of great antiquity and of undoubted Egyptian origin were discovered near the Wells of Moses, in the Sinaitic peninsula.

The country which lay to the south of Egypt is supposed to have produced iron in large quantities. Iron was also known to the Chaldeans, the Babylonians, and the Assyrians, who were cotemporaries of the early Egyptians. Some writers suppose that the Egyptians derived their supply of iron principally from these Asiatic neighbors and from the Arabians. Babylon was built about seventeen centuries before Christ, and Nineveh was of about equal antiquity. Iron ornaments have been found in Chaldean ruins, and Chaldean inscriptions show that iron was known to the most ancient inhabitants of Mesopotamia. In the ruins of Nineveh the antiquarian Layard found many articles of iron and inscriptions referring to its use. Among the articles discovered by him were iron scales of armor, from two to three inches in length. "Two or three baskets were filled with these relics." He also found "a perfect helmet of iron, inlaid with copper bands." In the British Museum there are preserved several tools of iron which were found at Nineveh by Layard, including a saw and a pick. The art of casting bronze over iron, which has only recently been introduced into modern metallurgy, was known to the Assyrians. At Babylon iron was used in the fortifications of the city just prior to its capture by Cyrus, in the sixth century before Christ. In a celebrated inscription Nebuchadnezzar declares: "With pillars and beams plated with copper and strengthened with iron I built up its gates." The huge stones of the bridge built by his daughter, Nitocris, were held together by bands of iron fixed in place by molten lead.

The Book of Job, which relates to a patriarchal period between Abraham and Moses, contains frequent references to iron, even to "bars of iron," "barbed irons," "the iron weapon," and "the bow of steel." In the 28th

chapter and 2d verse it is declared that "iron is taken out of the earth." In the 19th chapter and 24th verse the "iron pen," which could be used to engrave upon a rock, is mentioned. Job is supposed to have lived in the northern part of Arabia, in the Land of Uz, which was separated from Ur of the Chaldees, where Abraham was born, by the Euphrates. Iron ore of remarkable richness is still found between the Euphrates and the Tigris.

Moses led the children of Israel out of Egypt fifteen or sixteen hundred years before the Christian era. In the story of their wanderings iron is frequently mentioned. In Leviticus, vii. 9, the frying-pan is mentioned. When the Israelites under Moses spoiled the Midianites they took from them iron and other metals; when they smote Og, the king of Bashan, they found with him an iron bedstead. Canaan, the Land of Promise, was described by Moses in Deuteronomy, viii. 9, as "a land whose stones are iron." Iron is still made in the Lebanon mountains. In Deuteronomy, xxvii. 5, 6, and in Joshua, viii. 31, the use of iron tools in building an altar of "whole stones" to the Lord is prohibited, which shows that, not only did the Israelites in the days of Moses have a knowledge of iron tools that would cut stone, but that the Egyptians must have possessed the same knowledge. After the Israelites came into possession of Canaan iron is frequently mentioned in their history, some of the earliest references being to chariots of iron, which the Canaanites used in their wars with them, and which were probably armed with iron scythes. Chariots of the same kind were doubtless used by the Egyptians. Frequent mention is made of agricultural implements and tools of iron, and of iron weapons of war. In the description of the armor of Goliath it is said that "his spear's head weighed six hundred shekels of iron." Axes and saws and harrows of iron are mentioned in the reign of David, and axes and hammers and tools of iron in the reign of Solomon. Isaiah also speaks of harrows of iron. Daniel says that "iron breaketh in pieces and subdueth all things." When David, about a thousand years before Christ, made preparations for the building of the temple he "prepared iron in abundance for the nails for the doors of the gates and for the joinings;" and in his instructions to Solomon concerning it he said that he had prepared "brass and iron without weight," and that of gold, silver, brass, and iron "there is no number."

It would appear that the Israelites in the early part of their history were not skilled in the manufacture or manipulation of iron, but were greatly dependent upon their neighbors for iron itself and for the skill to fashion it. In the reign of Saul, because of the oppression of the Philistines, "there was no smith found throughout all the land of Israel; but all the Israelites went down to the Philistines to sharpen every man his share, and his coulter, and his axe, and his mattock." When Solomon came to build the temple he sent to Hiram, king of Tyre, for "a man cunning to work in gold, and in silver, and in brass, and in iron." The Phoenicians were celebrated as workers in all the metals.

In Jeremiah, xv. 12, the question is asked by the prophet: "Shall iron break the northern iron and the steel?" The northern iron and steel here referred to were probably products of Chalybia, a small district lying on the southeastern shore of the Euxine, the inhabitants of which, called Chalibees or Chalybians, were famous in the days of Asiatic pre-eminence for the fine quality of their iron and steel. Herodotus, in the fifth century before Christ, speaks of "the Chalybians, a people of ironworkers." They are said to have invented the art of converting iron into steel, but it is probable that, as they used magnetic sand, they made steel mainly. Latin and Greek names for steel were derived from the name of this people. From the same source we obtain the words "chalybean" and "chalybeate."

But other eastern nations doubtless made steel at as early a day as the Chalybians. In Ezekiel, xxvii. 12, the merchants of Tarshish are said to supply Tyre with iron and other metals, and in the 19th verse of the same chapter the merchants of Dan and Javan are said to supply its market with "bright iron." Tarshish is supposed to have been a city in the south of Spain, and Dan and Javan were probably cities in the south of Arabia. The name Tarshish may, however, have referred generally to the countries lying along the western coast of the Mediterranean and beyond the Pillars of Hercules. Dan and Javan may have supplied iron made in the southern part of Arabia, or they may have traded in the "bright iron," or steel, of India. The period embraced in the references quoted from the prophet was about six hundred years before Christ. Both Tyre and Sidon traded in all the products of the East and the West for centuries before and after Ezekiel, and iron was one of the products which they supplied to their neighbors, the Israelites.

The Persians and their northern neighbors, the Medes, made iron long before the Christian era, and so did the Parthians and other Scythian tribes. The Parthian arrow was first tipped with bronze, but afterwards with steel. The Parthian kings are said to have engaged with pride in the forging and sharpening of arrow-heads. Iron is still made in Persia by primitive methods.

India appears to have been acquainted with the manufacture of iron and steel from a very early period. When Alexander defeated Porus, one of the Punjaub kings, in the fourth century before the Christian era, Porus gave him thirty pounds of Indian steel, or wootz. This steel, which is still made in India and Persia, was a true steel, and of a quality unsurpassed even in our day. It was and still is manufactured by a process of great simplicity, similar to that by which crucible steel is now manufactured. Long prior to the Christian era, as well as for many centuries afterwards, Damascus, the capital of Syria, manufactured its famous swords in part from Indian wootz. The people of India further appear to have become familiar, at an early period in their history, with processes for the manufacture

of iron on a large scale which have since been lost. It is circumstantially stated that a cylindrical wrought-iron pillar is now standing at the principal gate of the ancient mosque of the Kutub, near Delhi, in India, which is about 60 feet long, 16 inches in diameter near the base, contains about 80 cubic feet of metal, and weighs probably over 17 tons. The immense proportions of this pillar are not more striking than its ornate finish. An inscription in Sanscrit is variously interpreted to assign its erection to the ninth or tenth century before the Christian era or to the early part of the fourth century after it. In the ruins of Indian temples there have been found wrought-iron beams similar in size and appearance to those used in the construction of buildings at the present time. Metallurgists are unable to understand how these large masses of iron could have been forged by a people who appear not to have possessed any of the mechanical appliances for their manufacture which are now necessary to the production of similar articles.

The period at which China first made iron is uncertain, but great antiquity is claimed for its manufacture in that mysterious country. In a Chinese record which is supposed to have been written two thousand years before Christ iron is mentioned, and in other ancient Chinese writings iron and steel are both mentioned. Pliny the Elder, writing in the first century of the Christian era, thus speaks of the iron of China, the inhabitants of which were known in his day as the Seres: "Howbeit, as many kinds of iron as there be, none shall match in goodness the steel that cometh from the Seres, for this commodity also, as hard ware as it is, they send and sell with their soft silks and fine furs. In a second degree of goodness may be placed the Parthian iron."

It may be assumed as susceptible of proof that the knowledge of the use of iron, if not of its manufacture, was common to all the people of Asia and of Northern Africa long previous to the Christian era. The Phœnicians would carry this knowledge to their own great colony, Carthage, which was founded in the ninth century before Christ, and to all the colonies and nations inhabiting the shores of the Mediterranean. Phœnician merchants obtained iron from such distant countries as Morocco and Spain, and possibly even from India and China, as well as from nearer sources. But in time the merchants of Tyre and the "ships of Tarshish" deserted the places that long had known them, empire after empire fell in ruins, and with the fading away of Asiatic and African civilization and magnificence the manufacture and the use of iron in Asia and Africa ceased to advance. Egypt has probably not made iron for nearly three thousand years, and probably no more iron is made in all Asia to-day than was made in its borders twenty-five centuries ago, when Babylon was "the glory of kingdoms, the beauty of the Chaldees' excellency."

THE EARLY USE OF IRON IN EUROPE.

The authentic history of the use of iron in Europe does not begin until about the period of the first Olympiad, corresponding to the year 776 before the Christian era, although both Grecian poetry and the traditions of the Grecian heroic age have transmitted to us many references to iron long prior to that period. About the time of Moses the Phœnicians are said to have introduced into Greece the art of working in iron and other metals. Minos, king of Crete, was indebted to them for the tools which enabled him to build his powerful fleet. In the fifteenth century before Christ the burning of the forests on Mount Ida, in Crete, is said to have accidentally communicated to the inhabitants the art of obtaining iron from native ores. This discovery enabled the Idæi Dactyli, who were priests of Cybele, to introduce the manufacture of iron and steel into Phrygia, a Greek colony in Asia Minor. So read some of the stories which have come down to us from the heroic age of Greece, and which, like the well-known story of Vulcan and his forges on the island of Lemnos, may be wholly fabulous; but there is nothing improbable in the conclusion which may be derived from them, that they point to a very early use of iron by the Greeks. From Phœnicia certainly, and probably also from Egypt, they would be likely to derive a knowledge of its use in the mechanic arts at least a thousand years before Christ. It is worthy of notice that the mythologies of both Greece and Egypt attributed the invention of the art of manufacturing iron to the gods—a fact which of itself may be regarded as establishing the great antiquity of the art in both countries.

The poems of Homer, who is supposed to have lived about 850 years before the Christian era, and therefore before the era of authentic Grecian history, make frequent mention of iron, and the art of hardening and tempering steel is fully described in the reference to the plunging of Ulysses' firebrand into the eye of Polyphemus—an act likened to that of the smith who "plunges the loud-hissing axe into cold water to temper it, for hence is the strength of iron." It would appear, however, from the offer by Achilles of "a mass of iron, shapeless from the forge," as a prize at the funeral games of Patroclus, that iron was not abundant in Greece at the time of the Trojan war, nor in the days of Homer himself. Troy fell in the year 1184 before the Christian era. The address of Achilles to the Greeks, when offering the prize, indicates how valuable iron was to them in the heroic age.

Stand forth, whoever will contend for this;
And if broad fields and rich be his, the mass
Will last him many years. The man who tends
His flocks, or guides his plow, need not be sent
To town for iron: he will have it here.

Homer mentions steel axes as valuable prizes to be contended for in the Grecian games, and he also mentions steel weapons of war, although rarely. He speaks again of some iron as being bright and white, the inference being

that steel is referred to. The Right Honorable William E. Gladstone, in his *Homeric Synchronisms*, says: "Iron is in Homer extremely rare and precious. He mentions nothing massive that is made of this material." Mr. Gladstone cites a number of references in Homer to iron and steel—the arrow-head of Pandaros, the dagger of Achilles, "the cutting tool of the chariot-maker for such fine work as shaping the felloe of the wheel," a knife for slaying oxen, and axes and adzes of steel. Hesiod, who is supposed to have been cotemporary with Homer, mentions iron and its qualities in his writings.

We come next to that period of Grecian history which introduces us to historical personages and historical events. Lycurgus, who lived about the time of the first Olympiad, required the Spartans to use iron as money; he "allowed nothing but bars of iron to pass in exchange for every commodity." These bars, for which iron rings or quoits were afterwards substituted, may have been made from the iron ores which were found in abundance in Laconia, or they may have been obtained abroad; but the use of iron as a measure of value in the days of Lycurgus indicates that this metal could not then have been a rare commodity. If it had been a precious metal Lycurgus would not have enforced its use as money. The iron ores of Elba were worked by the Greeks as early as the year 700 before Christ. They called the island *Æthalia*, "from the blazes of the iron works." The working of the ores of this island is mentioned by Herodotus, who lived in the fifth century before Christ; by Diodorus, a Sicilian historian of the first century before Christ; and by Strabo, a Greek traveler and geographer, who lived at the beginning of the Christian era. The Phœnicians made iron on the island of Eubœa at a very early day, and the Greeks afterwards actively prosecuted the same pursuit. Strabo speaks of the mines of Eubœa as being partially exhausted in his day. In Bœotia, on the mainland of Greece, iron was also made in very early times, and probably in other parts of the Grecian mainland and on the Grecian islands where iron ores are now found. On the island of Seriphos the ores are of the richest quality. Herodotus speaks of iron heads to lances and arrows in his day. He also mentions a silver bowl inlaid with iron, the work of Glaucus the Chian, which Alyattes dedicated at Delphi about the year 560 before Christ. Chalybian steel was imported into Greece in the time of Herodotus; and in the time of Aristotle, who lived a century later, the Greeks were themselves familiar with the manufacture of steel. Sophocles, who died in the year 406 before Christ, speaks of the tempering of iron in water. The manufacture of swords of steel about this time received some attention in Greece, as it did elsewhere. The father of Demosthenes, who was a manufacturer of arms, probably made steel swords. Iron and steel weapons of war began to displace those of bronze in most Mediterranean countries about the time of the battle of Marathon, which was fought in the year 490 before Christ. When Xerxes invaded Greece, ten years after the battle of Marathon, the Assyrians in his army carried wooden clubs "knotted with iron." The use of iron scythes as well as iron sickles was common among the Greeks about this time. Alexander, in the fourth century before Christ, is said by Pliny to have strengthened a bridge over the Euphrates, at Zeugma, with a chain made of links of iron. Daimachus, a writer who was cotemporary with Alexander, enumerates four different kinds of steel and their uses—the Chalybdiæ, Synopic, Lydian, and Lacedæmonian. Each kind of steel was adapted to the manufacture of a particular tool. From the Chalybdiæ and Synopic were made ordinary tools; from the Lacedæmonian were made files, augers, chisels, and stone-cutting implements; and from the Lydian were made swords, razors, and surgical instruments. The accounts left by this and other writers indicate great proficiency by the Greeks in the use of steel, and the possession of much skill in its manufacture.

A description of one of the "naval monsters" constructed by Archimedes for King Hiero, of Syracuse, about the middle of the third century before the Christian era, shows the great extent to which the use of iron had then been carried by the Greeks. "To each of the three masts was attached a couple of engines which darted iron bars and masses of lead against the enemy. The sides of the ship bristled with iron spikes, designed to protect it against boarding; and on all sides were likewise grapples which could be flung by machines into the galleys of the foe. The ship was supplied with twelve anchors, of which four were of wood and eight of iron."

According to accepted chronology, Rome was founded in the year 753 before the Christian era. It reached the culmination of its power about the end of the first century of that era. From its foundation to the beginning of its decline embraced a period of about nine hundred years. During the first part of this period Rome was favored with the experience of older nations in the use and manufacture of iron, and during the last part of it she greatly contributed by her energy and progressive spirit to extend its use and to increase its production. The Greeks were the great teachers of the Romans in all the arts, including metallurgy; but the Etruscans, who were the near neighbors of the Romans, and whom they in time supplanted, also contributed greatly to their knowledge of the arts of ancient civilization. The Etruscans, however, owed their civilization in large part to the Tyrrhenian Greeks, with whom they coalesced centuries before Rome was founded. Etruria was largely devoted to commerce, and among the countries with which it traded were Phœnicia and Carthage, as well as Greece and its colonies. From all these countries Etruscan civilization was invigorated and diversified, and Rome in its early days enjoyed the benefit of this invigoration and diversification. That it early acquired from the Etruscans a knowledge of the use and manufacture of iron can easily be imagined, and subsequent direct contact with Grecian colonies and with Greece itself would extend this knowledge. The island of Elba lay off the Etruscan coast, and, as has been already stated, its iron ores were extensively used by the Greeks about the time when Rome was founded. Its mines

were also worked by the Etruscans, and its ores were smelted both on the island and on the mainland. They were also taken to other countries to be converted into iron. After a lapse of twenty-five centuries the iron ores of this celebrated island are still exported, many cargoes finding their way to the United States. The Romans would also obtain iron from the islands of Corsica and Sardinia, but chiefly from the former. This island was occupied by the Ligurians and the Etruscans about the time of the founding of Rome, and by the Etruscans for centuries afterwards. The Carthaginians succeeded the Etruscans, and the Romans the Carthaginians. Iron was made in Corsica from the earliest times, and is still made in small quantities. The island has given a name to the Corsican forge, which is yet in use. A few years ago ten of these forges were in operation in Corsica, and they were probably almost identical in character with those which were used on the island when Rome was founded.

Iron is frequently mentioned in the early history of Rome. A war between the Romans and the Etruscans, the latter being led by their king, Porsenna, occurred in the year 507 before Christ, and among the conditions of peace exacted by the victorious Etruscan king was one which prohibited the Romans from using iron except for agricultural purposes. In the year 390 before Christ, when Rome was about to be ransomed from the Gauls, under Brennus, by a large payment of gold, Camillus, the Roman dictator, demurred, and declared that Rome should be ransomed with iron and not with gold, and that his sword alone should purchase peace. Another notable mention of iron in the early history of Rome occurs in the account of the defeat of the Carthaginian fleet in the first Punic war. The consul Duilius took command of the hastily-constructed Roman fleet, and upon encountering the Carthaginian fleet he connected his ships with those of the enemy by means of grappling-irons, through which, and the superior prowess of the Romans, he gained for Rome, in the year 260 before Christ, her first naval triumph. The Etruscan town of Pupluna furnished Scipio with iron in the second Punic war, and it is stated that many thousand tons of scoria are now lying on the beach close to its site.

Some of the swords and javelins of the Romans were made of iron or steel in the fifth century before the Christian era, but their agricultural implements, as has been shown in the reference to Etruria, were made of iron at an earlier period. The Roman battering-ram, which was borrowed from the Greeks, had a head of iron, and iron rings were placed around its beam. The Romans used this engine of war at the siege of Syracuse, in the year 212 before Christ. Prior to this time iron and steel tools were in common use among the carpenters, masons, shipwrights, and other tradesmen of Rome. At the beginning of the Christian era iron was in general use throughout the Roman Empire, the supply being derived from many countries which were subject to its sway. In the Acts of the Apostles, xii. 10, is a statement which indicates that iron was used at this period for architectural purposes and in public works. "When they were past the first and second ward they came unto the iron gate that leadeth unto the city." Iron was, however, used especially for tools, agricultural implements, and weapons of offense and defense. Pliny says that "iron ores are found almost everywhere," and that "the processes for refining the metal are nearly everywhere the same." It does not appear, however, that the Romans made iron at this time either at Rome or in its immediate vicinity. Pliny remarks that "in abundance of metals of every kind Italy yields to no land whatever, but all search for them has been prohibited by an ancient decree of the Senate." This prohibition probably applied only to the territory surrounding Rome. Vestiges of iron used by the Romans in the first century after Christ have been found in the ruins of the Coliseum, which was built by the emperor Vespasian. This iron was used as clamps to bind together the stones of that remarkable structure. Iron has also been found in the ruins of Pompeii, which was destroyed about the time the Coliseum was built.

In the northern part of Italy, just south of the Alps, corresponding to Piedmont and Lombardy of the present day, iron was made by the Romans in the first and second centuries before the Christian era. Pliny speaks of the excellence of the water at Comum, now Como, for tempering iron, although iron ores were not found there. Among the provinces which contributed largely to the Roman supply of iron at this time was Noricum, corresponding to Styria and Carinthia in Austria. Both Pliny and Ovid, who lived at the beginning of the Christian era, speak of Norican iron as being of superior quality, and it is certain that *ferrum noricum* was celebrated throughout Italy before their day. The best of swords were made from it in the reign of Augustus: Horace speaks of them. The spathic ores of Styria and Carinthia are still held in high favor; and the supply of ore, especially in the famous iron mountains of Erzberg and Huttenberg, shows no signs of exhaustion at the end of twenty centuries of almost constant use. Iron is still made in these provinces of Austria in small forges which are almost as primitive in character as those used by their ancient Celtic inhabitants. Celtic and Roman implements and medals, including a coin of the emperor Nerva, who lived in the first century of the Christian era, have been found in mounds of slag in the vicinity of Carinthian mines.

Cotemporaneously with the working of the Norican iron mines by the Celts, the Quadi, who inhabited the province of Moravia, lying north of Noricum, also made iron. The geographer Ptolemy, who lived in the second century of the Christian era, makes mention of the Quadi as ironworkers. Great antiquity is also claimed for the iron industry of that vast country which was known to the Romans as Sarmatia, now known as Russia in Europe. The nomadic Scythians would doubtless carry the art of ironmaking to the Ural mountains, where iron ore was and still is abundant. One of the Greek poets calls Scythia "the mother of iron"—Scythia comprising the countries lying north, east, and south of the Caspian sea.

The Phœnicians are known to have founded colonies in France and in Spain prior to the sixth century before Christ. They had settlements in Southern Gaul, on the Garonne and Rhone. The ancient city of Massilia, now Marseilles, is supposed to occupy the site of a Phœnician trading-post which fell into the possession of the Phœcean Greeks about the period we have mentioned, who gave to it great commercial and manufacturing importance. The Greeks also planted other colonies in Southern France. The city of Tartessus, or Tarshish, is supposed to have been one of the Phœnician settlements in the south of Spain; the city of Gades, or Cadiz, was another. Tartessus stood between the two arms of the Guadalquivir; but in the time of Strabo, who died about the year 25 of the Christian era, it had ceased to exist; Gades was its near neighbor, and still exists. It is probable that the Phœnicians introduced the manufacture of iron among the native inhabitants of France and Spain; the Iberians and Celtiberians of the latter country were certainly active in mining and working in metals several hundred years before the Christian era, and enjoyed an extensive trade in metals with Tyre and Carthage.

Under Grecian influence, which succeeded that of the Phœnicians in Spain, the Celtiberians, who inhabited the central and northeastern parts of the country, continued to make iron, and to this was joined the manufacture of steel. The famous forges of Aragon and Catalonia were active during the Grecian occupation of Spain. The Carthaginians for a brief time succeeded the Greeks in Spain, and about two centuries before the Christian era the Romans succeeded the Carthaginians. The Romans greatly extended the arts of their advanced civilization among the native inhabitants. They gave special encouragement to the manufacture of iron and steel, although in justice to the Celtiberians it must be said that their metallurgical skill was at least equal to that of the Romans. Polybius, a Greek historian who flourished in the second century before Christ, says that the helmet and armor of the Roman soldier were of bronze, but that the sword was a cut-and-thrust blade of Spanish steel. At the battle of Cannæ, in the year 216 before Christ, the Romans had learned from the Carthaginians at very great cost the value of the Spanish sword. Livy has recorded the fines which were imposed by Cato the Censor on the Celtiberian iron works after the Roman war with Spain in the year 194 before Christ. About the time these fines were imposed, the town of Bilbilis, near the present Moorish-built town of Calatayud, in Aragon, and the little river Salo were celebrated as the center of the iron district of Celtiberia. The water of the Salo was supposed to possess special qualities for the tempering of steel. The same excellence was attributed to other streams in Spain and in some other countries. Diodorus speaks of the excellent two-edged swords, "exactly tempered with steel," and of other arms which the Celtiberians in Aragon manufactured from rods of iron which had been rusted in the ground "to eat out all the weaker particles of the metal, and leave only the strongest and purest." He says that the swords which were manufactured from these rods "are so keen that there is no helmet or shield which cannot be cut through by them." Plutarch, who died about the year 140 of the Christian era, gives the same account of the Celtiberian method of purifying iron. Pliny speaks of the excellent iron of Bilbilis and Turiasso, the latter a town in Tarragona, and of an extensive mountain of iron upon the coast of Biscay, probably Somorrostro. Iron ore from the coast of Biscay is now exported in large quantities to Great Britain, the United States, and other countries. Toledo has been famous since the Roman occupation of Spain for its manufacture of swords, but this industry existed at Toledo before the appearance of the Romans. The town was captured by them in the year 192 before Christ. The Roman army from that time forward was provided with steel swords from Toledo and other places in Spain. The manufacture of Toledo blades probably attained its greatest development in the fifteenth and sixteenth centuries. The business still continues. A certain degree of mystery has always surrounded the manufacture of these swords, and the same may be said of the manufacture of the equally-celebrated Damascus blades.

The iron industry of Spain was the first in the world for many hundred years after the Romans obtained a foothold in the country, surviving the downfall of the Roman power in the peninsula, and flourishing under the subsequent rule of the Visigoths. This distinction was strengthened when the Moors became masters of the greater part of Spain, in the beginning of the eighth century of the Christian era. They stimulated the further development of the iron manufacture in the districts subject to their sway. At the same time the native inhabitants who had successfully resisted the Moorish arms continued to push their small Catalan forges still farther into the Pyrenees and along the coast of Biscay, lighting up the forests in every direction. So prominent did the iron industry of Spain become that its ironworkers were sought for by other countries, and on the French side of the Pyrenees, and in the mountains of Germany, and along the Rhine, they set up many of their small forges. The Catalan forge, which received its name from Catalonia, has been introduced into every civilized country of modern times that produces iron, and it still exists in almost its original simplicity in the mountains of both Spain and France.

France did not at an early period in its history make the same progress in the manufacture of iron that has been recorded of Spain, partly because it did not receive the same outside attention which made Spain a center successively of Grecian, Roman, Gothic, and Moorish civilization, but partly also because it did not possess iron ores of the same rich quality as those of Spain. It may be said, however, that the use of iron weapons was well known to the Gauls who confronted the Romans hundreds of years before the Christian era, and to their successors who opposed the armies of Julius Cæsar, who refers frequently to their use of iron. In speaking of the Veneti, who inhabited the southern part of Brittany, he makes the remarkable statement that the anchors for their ships were fastened to them with iron chains instead of cables. He also says that the benches of the ships were fastened with

iron spikes of the thickness of a man's thumb. This circumstantial statement denotes great familiarity with the use of iron by the Veneti. In describing the siege of Avaricum, the modern Bourges, a fortified town of the Bituriges, Cæsar says that "there are in their territories extensive iron mines, and consequently every description of mining operations is known and practiced by them."

For hundreds of years after Cæsar's time only faint glimpses are furnished us of an iron industry in France. During this period it was doubtless wholly confined to Catalan forges. *Stückofens*, or high bloomaries, were in use in Alsatia and Burgundy in the tenth century. When William the Norman invaded England in 1066 he was accompanied by many smiths who were armorers and horse-shoers, and therefore skilled workers in iron. The modern blast furnace is supposed to have originated in the Rhine provinces about the beginning of the fourteenth century, but whether in France or Germany or Belgium is not clear. A hundred years later, in 1409, there was a blast furnace in the valley of Massevaux, in France, and it is claimed by Landrin that France had many blast furnaces about 1450.

Iron was made by the Belgæ as early as the time of Julius Cæsar, and possibly at an earlier date. Heaps of iron cinder, which archæologists decide to be as old at least as the Roman occupation of Gallia Belgica, have recently been found on the tops of ferruginous hillocks in the provinces of Brabant and Antwerp, and in these cinder heaps flint arrow-heads and fragments of coarse pottery, characteristic of the earliest dawn of civilization, have been discovered. During the Roman occupation of the country iron was produced in many places in Belgium, a fact which is attested by heaps of cinder or slag which yet exist and are found in association with Roman relics. It has been supposed that the iron which was made in Belgium at this period was produced in low bloomaries without an artificial blast. We do not again hear of the Belgian iron industry until the tenth century, when high bloomaries, or wolf furnaces, otherwise *stückofens*, were in operation in the valley of the Meuse. We are informed that "iron was made to perfection in the Netherlands" in the twelfth century. In the fourteenth century high furnaces, or *flussofens*, were in existence in Belgium. In 1340 a furnace of this description was built at Marche les Dames, near Namur, to which, in 1345, special privileges were granted by William, count of Namur. These furnaces were true blast furnaces, producing cast iron. In 1560 there were in operation in Belgium, according to M. Déby, 35 blast furnaces and 85 forges.

Near Saarbrücken, in Rhenish Prussia, where the first battle between the French and the Germans was fought in the war of 1870, iron is said to have been made in the days of Roman ascendancy, but the Germans do not appear during this period to have been as familiar as their neighbors with its manufacture. Polybius, however, states that the Teutons and the Cimbri, from northwestern Germany, who invaded Italy and Gaul near the close of the second century before Christ, "were already familiar with iron, and possessed weapons of that metal." Tacitus informs us that "iron does not abound in Germany, if we may judge from the weapons in general use. Swords and large lances are seldom seen. The soldier grasps his javelin, or, as it is called in their language, his *fram*, an instrument tipped with a short and narrow piece of iron, sharply pointed, and so commodious that, as occasion requires, he can manage it in close engagement or in distant combat." He further says that the use of iron was unknown to the *Æstians*, who inhabited the northern part of Germany lying upon the Baltic; "their general weapon was the club." The Gothinians are described by Tacitus as a people who "submit to the drudgery of digging iron in mines" for the Quadi, who were their neighbors. Ernest, the German editor, says the Gothinians had iron of their own, and did not make use of it to assert their liberty. Tacitus wrote his *Treatise on Germany* about the close of the first century of the Christian era. From this time forward the condition of the German iron industry is enveloped in obscurity until the eighth century, when we hear of iron works, probably wolf furnaces or *stückofens*, in the district of the river Lahn, in Nassau, where iron of great celebrity was made by a guild of "forest smiths" in 780. We are informed by Maw and Dredge that "they had their special privileges, kept an iron mart at Wetzlar, and sent their products regularly to the great annual fairs at Frankfort-on-the-Main. This iron industry was especially flourishing during the thirteenth, fourteenth, and fifteenth centuries." During the eighth century we hear also of the iron industry of the principality of Siegen. There was a steel forge at the town of Siegen in 1288, which had been in existence before the eleventh century. The iron industry of Siegen was very active during the Middle Ages. About the middle of the thirteenth century *stückofens* were in use in Siegen. Percy says that in the beginning of the fifteenth century pig iron was made in Siegen in *blauofens*. Iron was made in Saxony as early as the eighth century. Alexander informs us that the *flussofen* was introduced into Saxony in 1550, and that the wooden bellows was invented about this time by Hans Lobsinger, an organist of Nuremberg. Iron was made in the Hartz mountains in the eighth century. In the Thuringian mountains wolf furnaces and bloomaries were in existence in the tenth century, and blast furnaces in the fourteenth century. Alexander states that in the latter half of the sixteenth century there was a furnace in these mountains 24 feet high and 6 feet wide at the boshes, built by Hans-sien, a Voigtlander. In 1377 cast-iron guns were made near Erfurt, in Thuringia. In the fifteenth century pots, plates, balls, etc., of iron were cast at the celebrated Ilseberg foundry in Germany. Stoves are said to have been cast for the first time in 1490, in Alsace.

Recurring to the iron industry of Austria, Alexander says that the mines of Styria were "opened again" in 712. It appears probable that wolf furnaces were in use in Styria, Carinthia, and Carniola as early as the eighth century,

which appears to be the epoch of their introduction in most European countries. The first blast furnace in the Alps provinces was, however, introduced very much later than in Belgium or on the Rhine—the first in Carinthia being built in 1567, at Urtl; the first in Styria in 1760, at Eisenerz; and the first in Carniola in the early part of the present century. Iron was made in Bohemia and Silesia at an early period. “The Bohemian chronicler, Hajek, of Liboschan, mentions that iron works existed in 677, near Schasslau.” Heaps of cinder and remains of wolf furnaces and ore bloomeries are numerous in Bohemia. In 1365 bloomeries were in use in Upper Silesia.

The iron industry of Sweden had an existence as early at least as the thirteenth century. A Swedish historian says that the oldest iron mine in Sweden is probably Norberg, in Westmanland, on the southern borders of Dalecarlia. There are documents still in existence, dated July 29, 1303, signed by Thorkel Knutson, the royal marshal, in which Norberg is mentioned as an iron mine. To the miners of Norberg, also, the first recorded privileges exclusively for iron mines appear to have been granted by King Magnus Ericsson, on February 24, 1354. In 1488 the mines of Dannemora were opened, and in 1614 Gustavus Adolphus encouraged the immigration of German furnacemen into Sweden. The celebrated iron works at Finspong were established in 1641 by Louis de Gier, from Liège, as a cannon foundry. The Walloon refining process, which takes its name from the Walloons, who were inhabitants of Flanders, was introduced into Sweden from Flanders in the time of Charles the Twelfth, who reigned from 1697 to 1718. Percy states that the osmund furnace, which was a modification of the *stüekofen*, was formerly very common in Sweden.

The iron industry of Russia dates historically from 1569, in which year, as recorded by Scrivenor, the English “obtained the privilege of seeking for and smelting iron ore, on condition that they should teach the Russians the art of working this metal.” The first historical iron works in Russia, however, were established long afterwards, according to the same author, in the reign of the czar Alexy Michaelovitch, about sixty miles from Moscow, and were the only ones in Russia prior to the reign of Peter the Great, who is said to have worked in them before he set out, in 1698, on his first journey into foreign countries. It is not known when the celebrated Russia sheet iron was first made. There is reason to believe that the Russians were skilled ironworkers and metallurgists long before the historic period above mentioned. The bells of Moscow have been famous for hundreds of years.

The use of iron in a limited way was known to the Britons before the invasion of England by Julius Cæsar in the year 55 before Christ. The Phœnicians, who traded with the Britons probably as early as the year 600 before Christ, may be supposed to have introduced among this barbarous people the use of iron, but we have no proof that they instructed them in its manufacture. The Greeks and Carthaginians succeeded the Phœnicians in trading with the Britons, but there is no evidence that they taught them the art of making iron. They, as well as the Phœnicians, probably took iron into Britain in exchange for tin and other native products. Cæsar, in his *Commentaries*, says of the Britons who opposed his occupation of the island that “they use either brass or iron rings, determined at a certain weight, as their money. Tin is produced in the midland regions; in the maritime, iron; but the quantity of it is small: they employ brass, which is imported.” This quotation from Cæsar would appear to establish the fact that iron was a precious metal in Britain at the time of his invasion; at least it would seem to show that it was not in common use, and could not have been used as an article of export. Cæsar nowhere mentions the use of iron weapons of war by the Britons. It is worthy of mention that the Belgæ had passed over to Britain before Cæsar’s time and made settlements upon its coast, and whatever arts they possessed they would of course take with them. It cannot be *proved* that the Belgæ made iron in their own country before Cæsar’s invasion of it; if it could be shown that they did, it might safely be assumed that they would introduce their methods of manufacture into Britain. Cæsar says that a small quantity of iron was made in the maritime regions of the island, and this the Belgæ may have made.

THE GROWTH OF THE BRITISH IRON INDUSTRY.

If the manufacture of iron by the Britons prior to the Roman invasion is enveloped in obscurity and even in doubt, there can be no doubt that iron was made in considerable quantities during the Roman *occupation* of Britain, which nominally extended from about the middle of the first century of the Christian era to the year 411. The Romans, it may here be remarked, were never themselves prominent as iron manufacturers in any country occupied by them; but, knowing the value of iron, they encouraged its manufacture wherever their arms were borne and the necessary conditions existed. The remains of iron works which were in existence and were operated during their stay in Britain are still pointed out. Dismissing all speculation concerning the origin of the first iron works in Britain, the remains of some of these works may well receive attention. They relate to a most interesting period in the history of the British iron trade.

Large heaps of iron scoria, or cinder, as old as the Roman era, have been discovered in the Wealds of Kent and Sussex, in the hills of Somerset, and in the Forest of Dean in Gloucester; also at Bierley, a few miles from Bradford in Yorkshire, and in the neighborhood of Leeds in the same county. There is also evidence that iron was made under the Romans in Northumberland, which is near Yorkshire; in Surrey, which adjoins Kent and Sussex; and in Monmouthshire, Hereford, and Worcester, which adjoin Gloucester. Except Bierley, Leeds, and Northumberland,

all the places and districts named as having produced iron lie in the southeastern or southwestern parts of England, or within the ancient boundaries of South Wales—"the country of the Silures." Next to Cornwall, where tin was obtained by the Phœnicians and their successors, these southern portions of the country would be most likely to be visited and influenced by foreigners before the Roman invasion. Cæsar described the island of Britain as being shaped like a triangle, with one of its sides looking toward Gaul. "One angle of this side is in Kent, whither almost all ships from Gaul are directed." The cinder mentioned has been found almost invariably in connection with Roman coins, pottery, and altars. A coin of Antoninus Pius, who lived in the second century after Christ, was found in the Forest of Dean in 1762, together with a piece of fine pottery. Coins of other Roman emperors have been found in the cinder heaps of the Forest of Dean. In the cinder beds of Beauport, between Hastings and Battle, in Sussex, a bronze coin of Trajan has been found, and one of Adrian. These emperors lived in the first and second centuries after Christ. Coins found in the cinder heaps of Maresfield, not far from Uckfield, have dates ranging from Nero to Diocletian, or from the year 54 to the year 286 after Christ. In the cinder mounds of Sussex many specimens of pottery have been discovered, including black and red Samian ware. On one of these, the base of a *patera*, is the potter's mark, "Albveiani." One relic consisted of a bronze *ligula*, very thin and elastic, more than four inches long, in good preservation, and having an elegantly-shaped bowl. Altars erected to Jupiter Dolichenus, the protector of iron works, have been discovered in various places in association with the remains of such works.

Much of the cinder has been found on the tops of hills or mounds, a circumstance which has led to the belief that bellows were not employed in producing a blast, but that the wind was relied upon to produce a draft sufficient to smelt the ore in charcoal bloomeries, some of which were mere excavations in the tops of hills, with covered channels leading to the hillside in the direction of the prevailing winds. This method of making iron is that which appears to have prevailed in Belgica at the same time. It is a curious fact that bloomeries of similar form and adaptation were in use in Derbyshire, for smelting lead, as late as the seventeenth century. Scrivenor mentions that similar furnaces were used by the Peruvians to smelt the silver ore of the country before the arrival of the Spaniards. Other air-bloomeries in England are supposed by Fairbairn and other writers to have been simple conical structures, with small openings below for the admission of air, and erected on high grounds that the wind might assist combustion. Iron is made to-day in Burmah without the aid of an artificial blast. The cinder found in England and Wales was very rich in iron; in the Forest of Dean it was so rich and so abundant that for many years after its discovery, a few centuries ago, about twenty small charcoal furnaces were engaged in smelting it.

Recent researches by Mr. James Rock, of Hastings, in Sussex, throw much new light on the Roman and early British methods of manufacturing iron. Cinder beds, or cinder heaps, were formerly very numerous in East Sussex, and many of them still exist. The neighborhood of Hastings appears to have been a great center of the iron industry "from the earliest times." The cinder heaps yet remaining are large enough to be quarried, and contain many thousand tons of scoria, some of the heaps having large oak trees growing upon their summits.

It was stated in 1681, by Andrew Yarranton, in the second part of his *England's Improvements by Sea and Land*, that "within 100 yards of the walls of the city of Worcester there was dug up one of the hearths of the Roman foot-blasts, it being then firm and in order, and was 7 foot deep in the earth; and by the side of the work there was found a pot of Roman coin to the quantity of a peck." The foot-blast here referred to must have been a leather bellows, with which the Romans and their Mediterranean neighbors were certainly acquainted. There is nothing improbable in the supposition that the Romans while in Britain used both the wind-bloomeries and the foot-blasts.

Strabo mentions the exportation of iron from Britain in his day. This was before the Romans had subdued the Britons, but after the influence of Roman civilization had been felt in the island. The emperor Adrian landed in Britain in the year 120, and in the following year there was established at Bath, in Wiltshire, a great Roman military forge, or *fabrica*, for the manufacture of iron arms. This forge was close to the bloomeries in Somerset and the Forest of Dean, from which it was supplied with iron. That the manufacture of iron at this time and for some time subsequent was almost wholly confined to the southern parts of England seems probable from a passage in Herodian, quoted by Smiles in his *Industrial Biography*, who says of the British pursued by the emperor Severus, in the year 208, through the fens and marshes of the east coast, that "they wore iron hoops round their middles and their necks, esteeming them as ornaments and tokens of riches, in like manner as other barbarous people then esteemed ornaments of silver and gold."

The Anglo-Saxons, who succeeded the Romans in the early part of the fifth century as the rulers of Britain, used iron weapons of war, and it is a reasonable supposition that they manufactured all the iron that was required for this purpose; but their enterprise as iron manufacturers probably extended but little further, although Bede speaks of the importance of the iron industry in his day, the beginning of the eighth century. The Anglo-Saxon monks frequently engaged in the manufacture of iron. Saint Dunstan, who lived in the tenth century, is said to have had a forge in his bedroom, and to have been a skilled blacksmith and metallurgist. During the ascendancy of the Danes, and afterwards down to the accession of William the Conqueror in 1066, iron was made in the Forest of Dean and elsewhere, but in limited quantities. In the eleventh century the Anglo-Saxon plow consisted of a

wooden wedge covered with straps of iron; to this the Normans added the coulter. The shipbuilders of Edward the Confessor, the last king of the Anglo-Saxons prior to Harold, who lost the battle of Hastings, obtained bolts and bars of iron from the city of Gloucester. The antiquarian Camden, quoted by Scrivenor and others, states that "in and before the reign of William the Conqueror the chief trade of the city of Gloucester was the forging of iron; and it is mentioned in *Doomsday-Book* that there was scarcely any other tribute required from that city by the king than certain *dicars* of iron and iron bars for the use of the royal navy. The quantity required was thirty-six *dicars* of iron; a *dicar* containing ten bars and one hundred iron rods for nails or bolts." Giraldus Cambrensis, who lived in the twelfth century, speaks of "the noble Forest of Dean, by which Gloucester was amply supplied with iron and venison." Nicholls, in *The Forest of Dean*, says that in the time of Edward the First, in the early part of the thirteenth century, the Free Miners of the Forest "applied for and obtained their 'customs and franchises,' which were granted, as the record of them declares, 'time out of mind.'" In 1282, according to Nicholls, there were "upward of seventy-two" *forgeæ errantes*, or movable forges, in the Forest, each of which paid a license of 7s. a year to the crown. Scrivenor states that during the period from the Conquest to the death of John, in 1216, iron and steel were imported into Britain from Germany and other countries. The Normans, however, contributed much to develop English iron and other resources. Green, in his *History of the English People*, says that one immediate result of the Conquest was a great immigration into England from the Continent. "A peaceful invasion of the industrial and trading classes of Normandy followed quick on the conquest of the Norman soldiery." Still the English iron industry made but slow progress. It is mentioned by Scrivenor that there were but few iron mines in the north of England in the thirteenth and fourteenth centuries, and that, in the tenth year of the reign of Edward the Second, in 1317, iron was so scarce in that section and in Scotland that the Scots, "in a predatory expedition which they made in that year, met with no iron worth their notice until they came to Furness, in Lancashire, where they seized all the manufactured iron they could find, and carried it off with the greatest joy, though so heavy of carriage, and preferred it to all other plunder." The Scots at this time were in great need of iron, which they did not produce, but for which they were wholly dependent on the Continent and on the favor or ill-fortune of England. Alexander says that there were iron works at Kimberworth, in Yorkshire, in 1160, and Smiles gives an extract from a contract for supplying wood and ore for iron "blomes" at Kirskill, near Otley, in Yorkshire, in 1352. A recent writer, Mr. H. A. Fletcher, says that "the earliest record which has been found of iron-ore mining in Cumberland seems to be the grant of the forge at Winefel to the monks of Holm Cultram Abbey, in the twelfth century, which also included a mine at Egremont, by inference of iron, being in connection with a forge; and Thomas de Multon confirms a gift to the same abbey *de quartuor duodenis mince ferri in Coupland*."

Scrivenor mentions one art related to the manufacture of iron which flourished in England from William to John, if the manufacture itself did not. The art of making defensive armor was brought to such perfection during the period mentioned that "a knight completely armed was almost invulnerable." The history of the Crusades shows that the English were then very proficient in the manufacture of both arms and armor, as were the Turks who resisted them. Smiles says that it was the knowledge of the art of iron forging which laid the foundation of the Turkish empire. By means of this art they made the arms which first secured their own freedom and then enabled them to extend their power.

Edward the Third, who reigned from 1327 to 1377, did much to advance the manufacturing industries of England. He protected domestic manufactures by legislation which restricted the importation of foreign goods, and he encouraged the immigration into England of skilled workmen from the Continent. The use of iron was greatly extended in his reign, and its manufacture was active in Kent and Sussex and in the Forest of Dean. Nevertheless the domestic supply did not meet the wants of the people. Scrivenor says: "By an act passed in the twenty-eighth year of Edward the Third no iron manufactured in England, and also no iron imported and sold, could be carried out of the country, under the penalty of forfeiting double the quantity to the king; and the magistrates were empowered to regulate the selling price and to punish those who sold at too dear a rate, according to the extent of the transaction." This act appears to have remained in force long after Edward's death. Smiles quotes from Parker's *English Home* the statement that in Edward the Third's reign the pots, spits, and frying-pans of the royal kitchen were classed among the king's jewels.

The methods of manufacturing iron which were followed in England in the thirteenth and fourteenth centuries were still of a slow and restricted character, although greatly advanced beyond those which existed in the days of the Romans. The English were yet mainly devoted to agriculture, and were not even good farmers, their implements of husbandry and their methods of cultivating the soil being equally rude. Wool was their great staple, and this was largely exported to the Continent, where it was manufactured into finer fabrics than the English were capable of producing. Iron was often scarce and dear, because the domestic supply was insufficient. The iron industry on the Continent was at this period in a much more advanced stage of development, and most of the Continental iron was also of a better quality than the English iron.

Professor James E. Thorold Rogers, in his *History of Agriculture and Prices in England*, gives many interesting details concerning the iron industry of England in the thirteenth and fourteenth centuries. Iron was made at this